SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1914.

CONTENTS.

GENERAL PHYSICS.

PAGE
1363. A Piezometric Sounding Instrument. *A. Berget* 465
1364. Instrument for recording Rate of Fall of Rains. *E. Esclangon* 465
1365. New Measuring Machine. *F. Göpel* 466
1366. Division Corrections of Toothed Wheels. *F. Göpel* 466
1367. Comparison of Standard Barometers in Vienna, Belgrade, and Rome. *W. Schmidt* 466
1368. Densities of Metals at Different Temperatures. *P. Pascal* 466
1369. Tension Elasticity of Copper. *G. Colonnetti* 467
1370. Plastic Deformation of Steel. *H. M. Howe & A. G. Levy* 467
1371. Fatigue Bending Tests on Mild Steel. *A. Martens* 467
1372. Effect of Notches in Continued Shock Tests. *E. Preuss* 468
1373. Surface Film on Polished Metals. *G. T. Beilby* 468
1374. Experiments on Three Struts. *M. Rudeloff* 468
1375. Photo-elastic Effect in Strained Glass. *L. N. G. Filon* 468
1376. Critical External Pressure on Thin Tubes. *R. v. Mises* 469
1377. Elasticity of Rubber at Small Pressures. *L. Bouchet* 469
1378. Damping of Vibrations in Various Materials. *I. Malmborg* 469
1379. 470
1380. Photographic Determination of Difference of Longitude. *G. Lippmann* 470
1381. Space Lattice of Diamond. *M. Born* 470
1382. Meteorological Observations: Antarctic Expedition. *E. Barkow* 470
1383. Frost Periods in South Germany. *R. Hennig* 471
1384. Reading the Traces of Balloon Meteorographs. *W. H. Dines* 471
1385. Depth of the Reversing Layer. *S. A. Mitchell* 472
1386. Electric Field of the Sun. *H. Deslandres* 472
1387. Spectrum of the Chromosphere. *P. Salet & Millochau* 472
1388. Pressure in Solar Reversing Layer. *J. Evershed* 472

PAGE
1389. Planetary Motions. *G. Nordström* 472
1390. Cosmic Dust in Solar System. *B. Fessenkoff* 472
1391. Stellar Spectra and Cosmical Evolution. *H. N. Russell* 473
1392. Distribution of Stars and Spectral Type. *A. S. Eddington* 473
1393. Probable Order of Stellar Evolution. *H. N. Russell* 473
1394. Enhanced Mn Lines in Spectrum of α Andromedæ. *F. E. Baxandall* ... 473
1395. Spectrum Variations of δ Cephei and ζ Geminorum. *I. Lehmann* 474
1396. Hydrogen and Nebula Spectrum. *J. W. Nicholson* 474
1397. New Algol-type Variable in Pegasus. *A. S. Williams* 474
1398. Short-period Variable XZ Cygni. *C. Martin & H. C. Plummer* 474
1399. Peculiar Variable Star. *E. C. Pickering* 474
1400. Proper Motions of Brighter Stars near Pole. *H. S. Jones* 474
1401. Temperature of Orion Nebula. *H. Bourget, C. Fabry & H. Buisson* 474

LIGHT.

1402. Mirror Astrolabe. *H. Chrétien* 475
1403. Coudé Spectrograph at Vienna. *A. Hnatek* 475
1404. Lateral Dark-ground Illumination. *G. Guglielmo* 475
1405. Doppler's Principle for Light. *C. Fabry & H. Buisson* 475
1406. Dispersion by Selenium. *K. Foesterling & V. Fréedericksz* 475
1407. Selenium Photometry. *E. Carlo* 476
1408. Ponderomotive Couple at a Source of Light. *P. S. Epstein* 476
1409. Spectrophotometric Study of Magnesium Platinocyanide. *F. G. Wick* ... 476
1410. Measurement of Reflecting Power. *J. Koenigsberger* 476
1411. Magnetic Double Refraction of Bravais' Iron. *A. Marchetti* 476
1412. Emissive Power in the Infra-red. *M. Drecq* 477
1413–1414. 477
1415. Variation of Titanium Furnace Spectrum. *A. S. King* 477
1416. Series Spectra and Quantum Hypothesis. *J. Stark* 478
1417. Lead Pencil Comparison Spectrum. *J. Lunt* 478
1418. Variations of Arc Spectrum. *M. Hamy & Millochau* 478
1419. Effect of Electric Fields on Spectrum Lines. *O. M. Corbino* 478
1420. Spark Spectra of Elements. *L. & E. Block* 478
1421. Interference of Röntgen Rays. *R. Glocker* 479
1422. Crystal Structure from Interference Photographs. *P. P. Ewald* 479
1423. Debye-effect. *E. Schrödinger* 480
1424. Secondary X-rays. *J. Laub* 481
1425. Passage of α-Particles through Hydrogen. *E. Marsden* 481
1426. Magnetic Spectrum of the β-Rays of Radium B + C. *J. Chadwick* 482
1427. Ionisation produced by γ-Rays. *R. D. Kleeman* 482
1428. γ-Radiation of Mesothorium and Radium. *O. Hahn* 482
1429. Active Deposit of Actinium. *E. Marsden & P. B. Perkins* 483
1430. 484

HEAT.

1431. Cooling of Spheres. *F. Vercelli* 485
1432. Diffusion-coefficient of Gases. *J. P. Kuenen* 485
1433. Natural Radiation from a Gas. *G. Green* 485
1434–1435. 485

ELECTRICITY AND MAGNETISM.

PAGE
1436. Measurement of e/m for Kathode Rays. *L. T. Jones* 486
1437. Electromagnetic and Gravitational Fields. *G. Nordström* 486
1438. Electrical Conditions of Atmosphere at Kew. *G. Dobson* 486
1439. Influence of Light upon the Spark. *M. Bonch-Bruevich* 487
1440–1441. 490
1442. Sensibility Curves for Selenium. *F. C. Brown & L. P. Sieg* 490
1443. Peculiarities of Powders of Antimony, Bismuth, and Galena. *G. Gehlhoff & F. Neumeier* 490
1444. Propagation of Electricity through Paraffin Oil. *G. G. de Villemontée* 491
1445. Passage of Electricity through Paraffin Oil. *G. G. de Villemontée* 491
1446. Demagnetising Factors of Cylindrical Rods in High Fields. *B. O. Peirce* 491
1447. Magnetic Properties of Chrome Steels. *M. B. Moir* 491
1448. Hall-effect in Flames. *H. A. Wilson* 492
1449. Osmo-antikathodic Vacuum Regulator. *C. Regaud* 493

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1450. Colloidal Solutions of Radio-active Substances. II. *F. Paneth* 494
1451. Action of Colloids on Radio-active Products. *T. Godlewski* 494
1452. Combustion of Air in the Voltaic Arc. *A. I. Gorbov & V. F. Mitkevitsch* ... 494
1453. Oxidation of Nitrogen in the Arc. *A. V. Schaposchnikow, A. Gudima, & V. Kütovski* 495
1454. Fixation of Atmospheric Nitrogen by Boron Compounds. *A. Stähler & J. J. Elbert* 496
1455. Ageing of Alloys of Silver and Tin. *W. A. Knight* 497
1456. Alloys of Aluminium and Silicon. *C. E. Roberts* 497
1457. Second Report to I. O. M. Corrosion Committee. *G. D. Bengough & R. M. Jones* 497
1458. Bronze. *J. Dewrance* 499
1459. Influence of Phosphorus on Cu-Al Alloys. *A. A. Read* 499
1460. Critical Ranges of Manganese Steel. *W. S. Potter* 500
1461. Structural Changes during Annealing. *D. Ewen* 500
1462. Embrittling of Iron by Caustic Soda. *J. H. Andrew* 501
1463. Nitride of Iron. *G. Charpy & S. Bonnerot* 501
1464. Thermal Expansion of Iron-Carbon Alloys. *J. Driesen* 502
1465. Influence of Nickel on Cu-Al Alloys. *A. A. Read & R. H. Greaves* 502
1466. Osmotic Pressure and Moist Air. *W. D. Bancroft* 502
1467. Flame Reactions. II. *W. D. Bancroft & H. B. Weiser* 503
1468. The Theory of Adsorption. *A. Eucken* 503
1469. The Critical Point, and Significance of *b* in Equation of van der Waals. *T. W. Richards* 504

CORRIGENDA.

Abstract No. 884, line 1 : *for* Tachymeters, *read* Telemeters. Also *p.* 284, end line : *for* tachymetry, *read* telemetry.

AUTHORS' INDEX.

Andrew, J. H., 1462.
Bancroft, W. D., 1466, 1467.
Barkow, E., 1382.
Baxandall, F. E., 1394.
Beilby, G. T., 1373.
Bengough, G., D., 1457.
Berget, A., 1363.
Bloch, E., 1420.
Bloch, L., 1420.
Bonch-Bruevich, M., 1439.
Bonnerot, S., 1463.
Born, M., 1381.
Bouchet, L., 1377.
Bourget, H., 1401.
Brillouin, L., 1414.
Bródy, I., 1435.
Brown, F. C., 1442.
Bruevich, Bonch-, M., 1439.
Buisson, H., 1401, 1405.
Carlo, E., 1407.
Chadwick, J., 1426.
Charpy, G., 1463.
Chrétien, H., 1402.
Colonnetti, G., 1369.
Corbino, O. M., 1419.
Deslandres, H., 1386.
Dewrance, J., 1458.
Dines, W. H., 1384.
de Doba, A. S., 1379.
Dobson, G., 1438.
Drecq, M., 1412.
Driesen, J., 1464.
Eddington, A. S., 1392.
Elbert, J. J., 1454.
Epstein, P. S., 1408.
Esclangon, E., 1364.
Eucken, A., 1434, 1468.
Evershed, J., 1388.
Ewald, P. P., 1422.
Ewen, D., 1461.
Fabry, C., 1401, 1405.
Fessenkoff, B., 1390.
Filon, L. N. G., 1375.
Foersterling, K., 1406.
Fréedericksz, V., 1406.
Gehlhoff, G., 1443.
Glocker, R., 1421.
Godlewski, T., 1451.
Göpel, F., 1365, 1366.
Gorbov, A. I., 1452.
Greaves, R. H., 1465.
Green, G., 1433.
Gudima, A., 1453.
Guglielmo, G., 1404.
Hahn, O., 1428.
Hamy, M., 1418.
Hennig, R., 1383.
Hnatek, A., 1403.
Howe, H. M., 1370.
Jones, H. S., 1400.
Jones, L. T., 1436.
Jones, R. M., 1457.
King, A. S., 1415.
Kleeman, R. D., 1427.
Knight, W. A., 1455.
Koenigsberger, J., 1410.
Kuenen, J. P., 1432.
Kutovski, V., 1453.
Laub, J., 1424.
Lehmann, I., 1395.
Levy, A. G., 1370.
Lippmann, G., 1380.
Lunt, J., 1417.
Malmborg, I., 1378.
Marchetti, A., 1411.
Marckwald, W., 1430.
Marsden, E., 1425, 1429.
Martens, A., 1371.
Martin, C., 1398.
Millochau, 1387, 1418.
v. Mises, R., 1376.
Mitchell, S. A., 1385.
Mitkevitsch, V. F., 1452.
Moir, M. B., 1447.
Neumeier, F., 1443.
Nicholson, J. W., 1396.
Nordström, G., 1389, 1437.
Paneth, F., 1450.
Pascal, P., 1368.
Perkins, P. B., 1429.
Pickering, E. C., 1399.
Plummer, H. C., 1398.
Potter, W. S., 1460.
Preuss, E., 1372.
Provotelle, 1441.
Read, A. A., 1459, 1465.
Regaud, C., 1449.
Richards, T. W., 1469.
Roberts, C. E., 1456.
Rudeloff, M., 1374.
Russell, H. N., 1391, 1393.
Salet, P., 1387.
Schaposchnikow, A. V., 1458.
Schmidt, W., 1367.
Schrödinger, E., 1423.
Sieg, L. P., 1442.
Sjöström, M., 1440.
Sommerfeld, A., 1413.
Stähler, A., 1454.
Stark, J., 1416.
Vercelli, F., 1431.
de Villemontée, G. G., 1444, 1445.
Weiser, H. B., 1467.
Wilson, H. A., 1448.
Wick, F. G., 1409.
Williams, A. S., 1397.

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1914.

GENERAL PHYSICS.

1363. *A Piezometric Sounding Instrument.* **A. Berget.** (Comptes Rendus, 158. pp. 1465–1467, May 18, 1914.)—Deep soundings are attended by numerous sources of error, principal among which is the shape taken by the line under water. The latter error is calculated by Krümmel, even in the most favourable case, to be at least one-thirtieth of the indicated depth. The present author has constructed a piezometer to avoid such error entirely, the principle being to measure the pressure at the depth attained by a manometric device. Water is adopted for the compressible fluid, since its compressibility is practically constant and its sensitiveness uniform at all depths. The instrument consists of a reservoir filled with water, whose base terminates in a long tube of ⅓ mm. internal diam. which communicates with a side vessel full of mercury and open for reception of the pressure. The tube is silvered internally and graduated externally. The whole apparatus is 25 cm. long. As the apparatus descends, the mercury is forced up the small tube and dissolves away the silver, thereby denoting the amount of compression, and hence the depth attained. The apparatus was first graduated experimentally by means of a hydraulic press. A thermometer is attached to the side of the piezometer to allow a correction for thermal dilatation. The sensitiveness of the apparatus may be increased to any extent by enlarging the volume of the water reservoir, and diminishing the cross-section of the graduated tube. H. H. Ho.

1364. *An Instrument for recording the Rate of Fall of Heavy Rains.* **E. Esclangon.** (Comptes Rendus, 158. pp. 1467–1470, May 18, 1914.)—The instrument consists essentially of a vertical tube with a comparatively small hole at the lower end which is otherwise closed. Rain is collected in a funnel of large diam. and allowed to flow into the open end of the tube. The velocity of discharge from the tube depends upon the pressure at the lower end of the tube, which in turn depends on the height of the column of water in the tube. Thus the latter is a measure of the rate of fall, for an increase in the rate demands a higher velocity of discharge which is automatically provided for by an increase in the head of water in the tube. R. C.

1365. *New Measuring Machine.* **F. Göpel.** (Zeitschr. Instrumentenk. 34. pp. 180–183, June, 1914. Communicated from the Physikal.-Techn. Reichsanstalt.)—This is to measure the diameter of a cylinder carrying a coil of wire. The measuring parts are light and, being provided with slide movements, can be easily moved to various parts of the cylinder. The latter is so mounted that it can be rotated on its axis when between the contacts of the measuring machine. Microscopes are used to measure the position of the contact rods which have pointed ends. P. E. S.

1366. *Division Corrections of Toothed Wheels.* **F. Göpel.** (Werkstattstechnik, 7. pp. 643 and 675, 1913. Zeitschr. Instrumentenk. 34. pp. 84–91, March, 1914. Abstract.)—A simple apparatus is described for the determination of the corrections of toothed wheels employed in instruments of precision. The errors are plotted as diagrams showing the correction necessary at any point. C. P. B.

1367. *Comparison of the Standard Barometers of the Central Meteorological Institutes in Vienna, Belgrade, Sofia, Bucharest, Athens, and Rome.* **W. Schmidt.** (Meteorolog. Zeitschr. 31. pp. 202–203, April, 1914.)—This comparison was undertaken by the Vienna Institute in response to a resolution of the Conference of Directors of Meteorological Institutes and Observatories which met at Innsbruck in 1905. The author performed the comparisons between Oct., 1910, and July, 1911. The total number of single readings upon which the comparisons are based is 2270. The following table shows the mean differences between the standard barometers at the places mentioned and the new "Marek" standard barometer of the Vienna Institute :—

	First Standard.	Second Standard.
Buda-Pesth	—0·009 mm.	—0·255 mm.
Belgrade	+0·012	—
Sofia	+0·183	—0·045
Bucharest	—0·027	—0·348
Athens	—0·193	—0·119
Rome	—0·085	—0·088

These results are considered to be fairly satisfactory. R. C.

1368. *Densities of Metals at Different Temperatures.* **P. Pascal.** (Rev. de Métallurgie, 11. pp. 469–479, May, 1914.)—A series of measurements were made of the densities of tin, lead, zinc, antimony, aluminium, and copper at temperatures considerably above the melting-points of the metals. The apparatus employed by the author consisted of a small electric furnace containing a crucible in which the metal was fused, the temperature of the metal being measured by a thermo-couple. A bulb of fused silica ware was fixed at one end of the beam of a balance and was immersed in the molten metal by means of a lead weight; at the other end of the beam a scale-pan was suspended for carrying a variable counterpoise. The temperatures between which the densities were determined were :—Sn from 232° C. to 988° C.; Pb, 327° to 969°; Zn, 418° to 918°; Sb, 631° to 1077°; Al, 658° to 925°; Cu, 1086° to 1295°. The results when plotted on curves show a regular diminution in density with rise of temperature. The author does not believe that these results should be used in calculating the contraction in volume which a metal undergoes in solidifying. The method is too indirect and would involve the comparison of very different samples of metal. [See Abstract No. 590 (1914).] F. J. B.

1369. *Tension Elasticity of Copper.* **G. Colonnetti.** (Accad. Lincei, Atti, 23. pp. 165–171, Feb. 1; 225–232, Feb. 15, and pp. 421–427, March 15, 1914. N. Cimento, 7. Ser. 6. pp. 11–18, Jan., and pp. 89–96, Feb., 1914.)—Investigates and tabulates the behaviour of copper under cycles of traction, and shows that the theory of elasticity covers only those cycles in which the traction is very small. E. E. F.

1370. *Plastic Deformation of Steel during Overstrain.* **H. M. Howe** and **A. G. Levy.** (Amer. Inst. Mining Engin., Bull. 88. pp. 585–600, April, 1914. Mech. Eng. 33. pp. 357–359, April 17, 1914. Abstract.)—The authors have made a microscopic study of the deformation of 0·2, 0·4, 0·75, and 1·45 per cent. carbon steels during the processes of cylindrical and conical punching, tensile testing, and wire-drawing. There are four aspects of flow in the plastic deformation of steel by overstrain: (1) the relative movements of the grains as a whole, (2) the relative movements of the cementite and pearlite within the grains, (3) the relative movements of the ferrite and cementite in the pearlite, and (4) the crystal unit slipping giving rise to the slip-bands of Ewing and Rosenhain. Intergranular movements are best shown by the uplifting of the grains on the upper surface of the plate polished previous to punching. The displacements are greater in cylindrical than in conical punching, but are confined to a narrower ring in the former case. Study of intra-pearlitic deformation shows that elongation or compression parallel to the stratification result in drawing out the cementite lines into squads and rearranging them *en echelon.* Sometimes the cementite lamellæ curve greatly, but cementite islands resulting from divorce annealing [see Abstract No. 886 (1913)] are shattered. F. C. A. H. L.

1371. *Fatigue Bending Tests made between* 1892 *and* 1912 *in the Materialprüfungsamt in Berlin-Lichterfelde on Mild Steel.* **A. Martens.** (Königl. Materialprüfungsamt, Mitt. 32. 1. pp. 51–85, 1914.)—Static and dynamic tests have been carried out on 41 examples of mild steel of different composition. The static tests included determinations of the yield-point (σ_S), elastic limit (σ_P), tensile strength (σ_B), and elongation (δ). Dynamic tests were carried out in a machine of the Wöhler type, by loading a 1·5-m. bar at both ends so that the stress (σ_A) on the outer fibres of the centre of the bar was 300 kg./cm.^{2}, and counting the number of revolutions required for fracture (ΣA). In one series, tensile tests were subsequently made on various portions of the fractured bar. During the bending tests a rough estimate was made of the rise in temperature at the centre of the bar. The results are collected in a 20-page table, and plotted in the form of curves showing log ΣA as functions of temperature-rise, σ_A/σ_P, σ_A/σ_S, and σ_A/σ_B. From the results the following conclusions can be drawn:—(1) When considerable heating takes place during fatigue tests, fracture will occur with less than 10^6 revolutions; but when the heating up is only slight, the number of revolutions required for fracture under identical conditions is considerably increased. (2) Fracture will only take place after a very large number of alternations (over 10^6) when $\sigma_A < \sigma_P$ or when $\sigma_A/\sigma_S < 0{\cdot}85$ or $\sigma_A/\sigma_B < 0{\cdot}45$. In alternating stress tests the permanent deformation exerts a far greater effect on the yield-point and elastic limit than on the tensile strength. Curves are also given showing the effects of annealing and of chemical composition on log ΣA. The phenomena occurring during fatigue are so complicated that it becomes exceedingly difficult to offer a plausible theoretical explanation for the results. Effects of the alteration of shape and heating-up during the tests on the original mechanical properties; effects of variations in composition of, mechanical and thermal treatment of, and existence or non-existence of segregated areas in the material,—all tend to complicate matters and make a complete study of the subject very expensive both in time and money. F. C. A. H. L.

1372. *Effect of Notches in Continued Shock Tests.* **E. Preuss.** (Zeitschr. Vereines Deutsch. Ing. 58. pp. 701–708, May 2, 1914.)—In an earlier paper the author has shown that in a simple tensile test the effect of a notch is to increase the stress at the smallest diam. to between 1·48 and 2·48 times (depending on the shape of the notch) that which would exist in a plain bar of the sectional area at the bottom of the notch. During dynamic testing the effect is very much greater because there is so little time for stress-equalisation. Tests have been made in a Krupp impact bending machine (similar to that of Stanton) on mild steel bars provided with notches of different shape and size in comparison with plain cylindrical bars. In each case the minimum diam. was the same and equal to 18 mm. The results show that the deep notch always gives lower values than the shallow notch, and that the plain bars require 10·2 to 22·6 times as many blows for fracture as the notched bars. V-shaped notches give the lowest value. Attention is drawn to the dangers arising from stamping letters, figures, etc., in articles which are going to be subjected to shock. F. C. A. H. L.

1373. *Surface Film on Polished Metals.* **G. T. Beilby.** (Roy. Soc., Proc. Ser. A. 89. pp. 593–595, March 2, 1914. Nature, 92. p. 691, Feb. 19, 1914.)—Shows that the minute pits in a polished surface of copper are covered by a transparent or highly translucent film which crosses the empty pit without any support from below. By suitable methods of polishing the skin developed on the surface may be raised to a maximum thickness or reduced to a minimum. Photomicrographs in natural colours accompany the paper, and show the bluish film crossing the pits and the empty pits after the film has been dissolved by a 10 per cent. solution of ammonium persulphate acting for 20 to 30 seconds. The thickness of the film is probably of the order of 10 to 20 $\mu\mu$. E. E. F.

1374. *Experiments on Three Struts.* **M. Rudeloff.** (Verein z. Beförd. des Gewerbfleisses, Verh. 3. pp. 147–218, March, 1914.)—Describes elaborate experiments on struts. The shortening due to compression, and the lateral deflection are measured for the strut as a whole and for its component struts between the cross bindings. At each end plate of the strut is a ball seating, and the tilting of the end plate is observed. The results are given in copious tables. H. S. R.

1375. *Photo-elastic Effect in Strained Glass.* **L. N. G. Filon.** (Roy. Soc., Proc. Ser. A. 89. pp. 587–593, March 2, 1914.)—Investigates the manner in which the stress-optical coefficients of glass vary with the change of temperature. Glass slabs were enclosed in a double-walled copper chamber, and a circulation of steam was maintained between the walls. Light, after traversing the glass, was focused in a spectrographic camera. In the later experiments, prisms of small angle were cut from the material of the slabs, and the deflections of the various spectrum lines read off at the lower and higher temperatures. The author gives a table of the stress-optical coefficients for a Jena glass UV8199, and shows their variation in diagrams. They do not appear to be permanently fixed, but to vary with the time and the life-history of each individual piece of glass. E. E. F.

1376. *Critical External Pressure on Thin Tubes.* **R. v. Mises.** (Zeitschr. Vereines Deutsch. Ing. 58. pp. 750–755, May 9, 1914.)—Derives an equation from the theory of elasticity and gives tables and curves to facilitate its application. Within the elastic limit, the equation given has a significance similar to that of Euler's equation for struts. Applications of the equation beyond the elastic limit are discussed by the author. H. S. R.

1377. *Elasticity of Rubber at Small Pressures.* **L. Bouchet.** (Comptes Rendus, 158. pp. 1495–1498, May 25, 1914.)—Describes experiments on the compressibility of a water-filled cylinder of rubber totally immersed in water in a glass vessel. This vessel communicated by means of a stout connector with a glass tube the height of which was variable by means of a screw, and the amount of its motion capable of accurate measurement. By arranging that the area of the water surface in the vessel should be very large compared with that in the tube it was possible by raising the tube to produce exceedingly small but accurately determined changes in level (*i.e.* in pressure) in the gauge vessel. The rubber cylinder communicated at its upper extremity with a capillary tube, the level of the water in which was accurately determinable. The rubber was first subjected to a cycle of pressures traversed by definite small increments, the level of the water in the capillary being measured at each pressure 15 secs. after the application of that pressure. The deformations were found proportional to the applied pressures. A second cycle, traversed continuously and more rapidly, showed that in this case the deformations increased more quickly than the pressures and that the effects at increase and decrease were not the same. The value of Young's modulus calculated from the results obtained by this method was in fair agreement with the modulus found by tension. J. W. T. W.

1378. *Damping of Vibrations in Various Materials.* **I. Malmborg.** (Ann. d. Physik, 44. 3. pp. 337–368, May 26, 1914.)—Describes experiments on some of the materials generally in use for lessening the tendency to vibration in systems subjected to impact. The substances employed included rubber, cork, and felt, the last-named being investigated both in the dry state and when soaked in various viscous fluids. A heavy cylinder was suspended by a bifilar system between two pads of the substance under investigation. These pads were pressed against the flat ends of the cylinder by massive blocks so arranged that different pressures could be produced on the pads. The cylinder was set in vibration by an axial blow of approximately known strength. The vibrations were registered photographically by means of a mirror, the time being similarly recorded from an electrically maintained tuning-fork. Experiments were made with three different strengths of impact, and with the material under varying degrees of pressure. It is found that the coefficient of damping for any material under constant pressure is practically independent of the intensity of the impact, and that this coefficient of damping, as well as the logarithmic decrement, are relatively small for the materials generally in use. An elastic material soaked in a viscous fluid, however, shows a very great improvement in both respects. Extensive tables and curves are given showing the behaviour of the different substances and these should be consulted if more detailed results are desired. J. W. T. W.

1379. *Equations of Thermo-elasticity derived from Principle of Least Action.* **A. S. de Doba.** (Deutsch. Phys. Gesell., Verh. 16. 10. pp. 475–478, May 30, 1914.)—Mathematical. E. H. B.

1380. *Photographic Determination of Difference of Longitude.* **G. Lippmann.** (Comptes Rendus, 158. pp. 909–912, March 30, 1914.)—A device is described wherewith it is possible to obtain a photographic record of the difference of longitude between two stations without any transit instrument or personal observation error. A telescope is arranged to photograph a small region of the zenith at each station. Into each of these a collimator is adjusted so as to project the image of a small illuminated slit on the plate showing the star images, the beam of light from the collimator being adjusted to exact verticality by a mercury surface. By these means the artificial images are impressed simultaneously on the star plates at the two stations by employing electric sparks operated by a mechanical device to discharge exactly in unison with the receipt of a wireless signal from some central station such as the Eiffel Tower. The difference in right ascension of the two artificial marks on the photographs is then obtained from a knowledge of the star positions from standard catalogues. By taking a series of exposures on each plate the accuracy of the result can be appreciably increased.

C. P. B.

1381. *Space Lattice of Diamond.* **M. Born.** (Ann. d. Physik, 44. No. 4. pp. 605–642, June 4, 1914.)—A mathematical paper the scope and results of which may be thus summarised :—(1) According to the Braggs the diamond space lattice has the property that each carbon atom has four neighbours. Under the assumption that only these four neighbours exert molecular forces on the atom, diamond is shown to have only two molecular elasticity constants. (2) The vibrations proper to the lattice are rigorously calculated. It is shown that, as for the simplest regular lattice, the frequency is determined by a cubic. (3) The limiting case of long waves furnishes the relation between the three measurable and the two molecular elasticity constants. Among the measurable constants there is an equation of the second degree. (4) The formula for the specific heat is developed in a series in the reciprocal powers of the temperatures, according to the method of Thirring, and the first seventeen coefficients of the series are calculated. (5) The tabulation and plotting of the specific heat for various values of the elasticity constants is thus possible, and accordingly also comparison with the results of observations. (6) For an isolated carbon atom the appropriate frequency corresponds to a rest-ray wave-length of 11 μ, in accordance with Einstein's statement. The frequency used by Debye may thus be calculated theoretically. E. H. B.

1382. *Meteorological Observations of the German Antarctic Expedition, 1911–1912.* **E. Barkow.** (Meteorolog. Zeitschr. 31. pp. 120–126, March, 1914.)—The expedition passed South Georgia in Dec., 1911, and reached the Antarctic continent on Jan. 30, 1912. In March the *Deutschland* attained her southernmost point (77° 45′ S.) in the Weddell Sea. On Dec. 17, 1912, the vessel regained the open sea. The more noteworthy of the facts brought out by the ordinary meteorological observations are the numerous periods when the barometer was extremely low, the low temperatures (mean $-18{\cdot}7^\circ$ C. but the absolute minimum was only $-36{\cdot}9^\circ$ C.), the small diurnal range of temperature ($\not>3^\circ$ C.), the comparative infrequency of gales and calms and the frequent occurrence of surface winds from all points of the compass, although the directions from SE. to W. are noted most often.

Ascents of kites, registering balloons, and pilot balloons were made. A noteworthy feature is the frequency and magnitude of temperature inversions, the greatest of these being of 19½° C. in June. Above an inversion there usually occurs a layer of air which is nearly isothermal in a vertical direction. Observations with pilot balloons are specially interesting in view of theories of atmospheric circulation in the neighbourhood of the South Pole. Cases are found in which a strong westerly current occurs above a SE. surface wind of some 2000 m. in depth, thus agreeing with Meinardus' view of the circulation. On the other hand, on March 29, 1912, an east wind at the surface was succeeded by a NE. wind aloft, which persisted to the max. height attained, 9750 m. R. C.

1383. *Frost Periods in South Germany.* **R. Hennig.** (Meteorolog. Zeitschr. 31. pp. 109–120, March, 1914.)—Apart from purely local influences the Alps considerably affect the climate of South Germany, for they modify the large oceanic depressions and they also completely prevent the Mediterranean influences, as exhibited by the climate of Northern Italy, from extending northward into Germany. The mountain ranges of Central Germany also affect the climate of South Germany by holding back the depressions which influence the weather of Northern Germany. A frost may prevail in the South when cyclonic conditions with temperatures above the freezing-point are experienced in the North.

The results of registering balloons at Lindenberg are utilised to predict the break-up of a frost period. Examples are shown of the variation of temperature with height on consecutive days at the end of a frost. The curves show a large temperature inversion above the cold surface layers with the usual fall of temperature above the inversion. The rate of fall of temperature gradually becomes more rapid on successive days until instability sets in concurrently with the break-up of the frost. R. C.

1384. *Calibration and Reading the Traces of Balloon Meteorographs.* **W. H. Dines.** (Meteorolog. Office, Geophysical Mem. No. 6. pp. 147–152, 1914.)—The meteorograph consists of an aneroid box and a bimetallic thermometer. The record is obtained on a piece of silvered brass about the size of a postage stamp, and consists of a curve which represents simultaneous variations in pressure and temperature on a system of polar co-ordinates, in which the radius vector corresponds with temperature, the scale being nearly linear, while the angular co-ordinate gives roughly the pressure. The paper describes the method adopted by W. H. Dines to calibrate each record. The exact positions of definite pressures at definite temperatures are marked on the record itself before the ascent. When the actual record of the ascent has been obtained on the plate, corresponding recorded values of pressure and temperature are measured by placing the plate on the specially-constructed stage of a microscope which gives the polar co-ordinates above referred to by a scale in the eyepiece of the microscope and a scale and screw on the stage respectively. These are plotted on squared paper with reference to rectangular co-ordinates and the calibration marks are also measured and plotted. From the resulting diagram corresponding values of pressure and temperature for the ascent are obtained exactly by interpolation between the calibration lines. Values of temperature and height are derived from these by means of Laplace's formula; a graphical method, using semi-logarithmic paper and a special set-square, being employed. There is reason to suppose that the probable errors of the recorded temperatures are less than 1° C., and that the error of the height at the base of the isothermal region (say at 8 to 11 km.) is less than 200 m. [See Abstract No. 1685 (1912).] R. C.

1385. *Depth of the Reversing Layer.* **S. A. Mitchell.** (Astrophys. Journ. 39. pp. 166–179, March, 1914.)—In the course of the analysis of the chromospheric spectra obtained at the total solar eclipse in 1905 [Abstract No. 616 (1914)], comparisons were made with the intensities of the lines with the lines of the Fraunhofer spectra, and also with laboratory arc and spark spectra. In addition, the lengths of the bright arcs were also determined, thereby giving material for computing the depth of the chromosphere corresponding to each spectrum line. The tabulation of the results is given for groups of elements, the grouping being in accordance with the periodic table. Some very noticeable differences are at once apparent; for instance the Fe-group lines extend to the least heights, and the lines of the rare-earth elements to the greatest heights. Also the enhanced lines, which are in all cases much stronger in the chromosphere than those not enhanced, extend to greater heights, the heights actually depending on the degree of enhancement. C. P. B.

1386. *Electric Field of the Sun.* **H. Deslandres.** (Comptes Rendus, 158. pp. 1137–1142, April 27, 1914.)—A discussion is given of the possibility of certain phenomena exhibited by the solar atmosphere being in whole or part due to the Stark-effect. Attention is drawn to the differences shown by laboratory experiments between the Stark electrical effect and the Zeeman magnetic effect. C. P. B.

1387. *Spectrum of the Chromosphere.* **P. Salet** and **Millochau.** (Comptes Rendus, 158. p. 1000, April 6, 1914.)—Several photographs of the spectrum of the solar chromosphere have been made with the large spectrograph attached to the equatorial of the Paris Observatory, the solar limb being doubled by Coudé interposing an Iceland-spar rhomb. The chromospheric lines showed almost the same appearance in the two spectra, thus suggesting that the Stark-effect due to a possible magnetic field is very feeble if at all existent. It is hoped to test the method further by means of greater dispersion apparatus. C. P. B.

1388. *Pressure in Solar Reversing Layer.* **J. Evershed.** (Kodaikanal Observatory, Bull. No. 36. Nature, 93. p. 224, April 30, 1914. Abstract.)—A new explanation is suggested to account for the general displacement of solar spectrum lines towards the red, which has of late years been ascribed to pressure effects. The author now shows that, after considering possible differences of level, the absolute and relative shifts can be satisfactorily accounted for by motions in the line of sight. He finds that in the higher regions of the solar atmosphere there is a movement of descent which is retarded in the lower levels. C. P. B.

1389. *Planetary Motions.* **G. Nordström.** (Ann. d. Physik, 43. 7. pp. 1101–1110, April 2, 1914.)—An examination is made of the formulæ for planetary orbital motions, employing the problem of relativity in the analysis. C. P. B.

1390. *Cosmic Dust in Solar System.* **B. Fessenkoff.** (Comptes Rendus, 158. pp. 1001–1003, April 6, 1914.)—An attempt is made to determine the probable relative density of the cosmical dust which is thought to exist in planetary space, the results being given in terms of the distance from the sun. The variation in density found is from 1·0 at unit distance, to 5·2 at distance 0·10. C. P. B.

1391. *Stellar Spectra and Cosmical Evolution.* **H. N. Russell.** (Nature, 93. pp. 227–230, April 30; 252–258, May 7, and pp. 281–286, May 14, 1914. Paper read before joint meeting of Astronom. and Astrophys. Soc. of America, and Amer. Assoc. for Advancement of Science, Dec., 1913.)—An attempt is made to correlate the recent results with regard to stellar parallax, proper motion, mass, brightness, and spectral type, in the endeavour to find some systematic indication of the method of evolution of cosmical bodies. It is shown that the differences in brightness between the stars of different spectral classes do not arise directly from differences of mass, and that probably the mean masses of the various groups of stars are extraordinarily similar. Also that the surface brightness of the stars diminishes rapidly with increasing redness. Evidence is given for accepting the view of stellar evolution consisting of two stages: an increase of brilliancy with advance of spectral type from red stars to white stars, with gradual increase of density due mainly to contraction, then a subsequent decrease of brilliancy with further advance of spectral type to another kind of red stars, accompanied by a further increase of density. This leads to various interesting proposals respecting giant and dwarf stars, as first suggested by Hertzsprung. [See also Abstract No. 200 (1914).] C. P. B.

1392. *Distribution of Stars and Spectral Type.* **A. S. Eddington.** (Cambridge Phil. Soc., Proc. 17. No. 4. p. 351, Jan. 30, 1914.)—The concentration of stars to the galactic plane is not shown equally by the different spectral classes, type B being chiefly represented. At one time this was regarded as possibly due to difference of distance according to the form of the stellar system, but this view does not accord with the determinations by Boss and Campbell of the average distances of stars of different spectral type. It appears now that the M type stars are on the average more remote and more luminous than those of type A. This raises the point whether the view of evolution shall be that the earliest type, having small velocities, are confined mainly to the galactic plane, or that they are more uniformly dispersed and possess initial high velocities as proposed by Russell. The author inclines to the former view. C. P. B.

1393. *Probable Order of Stellar Evolution.* **H. N. Russell.** (Observatory, No. 473. pp. 165–175, April, 1914.)—The question of the separation of stars of spectral type M into two groups in widely different stages of evolution has been criticised by Eddington [see preceding Abstract]. Discussing the data obtained from parallax observations of proper-motion stars it is suggested that the results leave no doubt that the number of stars of type M of brightness comparable with that of the sun must be very small compared with the number of those 100 times fainter. Further details are given of the author's views regarding the order of evolution of stars of various types of spectra. C. P. B.

1394. *Enhanced Lines of Manganese in Spectrum of α Andromedæ.* **F. E. Baxandall.** (Roy. Astronom. Soc., M.N. 74. pp. 250–256, Jan., 1914.)—Certain peculiar lines in the spectrum of α Andromedæ have been shown to be due to manganese under "enhanced" conditions, the agreement in wave-length being so close as to leave little doubt. Certain differences of relative intensity of the lines as found in laboratory spectra and in the star spectrum are discussed, as these may be due either to differences of electrical condition in the star's atmosphere, or to the effect of closely neighbouring lines of other elements. C. P. B.

1395. *Variations of Spectrum Intensity of δ Cephei and ζ Geminorum.* **I. Lehmann.** (Acad. Sci. St. Pétersbourg, Bull. 6. pp. 423–428, April 1, 1914.)—Measurements were made on 33 plates of the spectrum of δ Cephei, and on 13 of the spectrum of ζ Geminorum, taking one plate as standard in each case. From the varying intensities of a selected series of lines a light-curve is deduced which shows remarkable similarity to the light-variation curve given by Stebbins by direct photometric determination. C. P. B.

1396. *Hydrogen and Nebula Spectrum.* **J. W. Nicholson.** (Roy. Astronom. Soc., M.N. 74. pp. 204–214, Jan., 1914.)—From the similarity of the wave-length formulæ for hydrogen and the nebula spectrum it appears likely that hydrogen marks a stage in the evolution of matter from a certain simple ring system. This idea is developed by an analysis of the various modifications of spectrum lines which may be produced by assuming different groupings of the electronic system. C. P. B.

1397. *New Algol-type Variable in Pegasus.* **A. S. Williams.** (Roy. Astronom. Soc., M.N. 74. pp. 215–225, Jan., 1914.)—Observations of the magnitude of a star in Pegasus show that it exhibits variability of the Agol type. Details are given from June, 1904, to Sept., 1907. The star is about the 10th magnitude. C. P. B.

1398. *Short-period Variable XZ Cygni.* **C. Martin** and **H. C. Plummer.** (Roy. Astronom. Soc., M.N. 74. pp. 225–238, Jan., 1914.)—Details of observations are given of the short-period variable discovered by Cereski in 1905. The mean photographic magnitude is 9·29. C. P. B.

1399. *Peculiar Variable Star.* **E. C. Pickering.** (Nature, 93. p. 198, April 23, 1914.)—Magnitudes for the period 1890–1912 are given for the peculiar star (081041, −41° 3911, HV3372). At first inspection the star appears to be a variable with period of about 20 years, varying from the eleventh to fourteenth magnitude. It is mentioned, however, that all other known long-period variables have a different spectrum to that of this star, and have periods not greater than 2 years. In this case the variations are probably irregular, and similar to those of the R Coronæ class. C. P. B.

1400. *Proper Motions of Brighter Stars near Pole.* **H. S. Jones.** (Roy. Astronom. Soc., M.N. 74. pp. 168–200, Jan., 1914.)—A detailed discussion is given of the relationship between the proper motions and spectral type of a number of the brighter stars within 17° of the Pole. The result of the investigation gives additional confirmation to the now well-established fact that the average stellar velocity increases progressively with advancing spectral type. C. P. B.

1401. *Temperature of Orion Nebula.* **H. Bourget, C. Fabry** and **H. Buisson.** (Comptes Rendus, 158. pp. 1017–1019, April 6, 1914.)—Interferential spectroscopic observations on the Orion nebula have been made from 1911 at the Marseilles Observatory, and from the results it is concluded that the strong double ultra-violet line at λ3726–3729 is due to a gas having an atomic weight of about 3, while the chief nebula line at λ5006 appears to be due to an element of atomic weight greater than hydrogen, but less than that giving the ultra-violet lines. Taking the limit of interference for hydrogen suggests that the temperature of the nebula is about 15,000°. C. P. B.

LIGHT.

1402. *Mirror Astrolabe.* **H. Chrétien.** (Comptes Rendus, 158. pp. 1144–1146, April 27, 1914.)—A modification of the Claude and Driencourt prism astrolabe is proposed, substituting for the prism a mercury bath and two plane reflectors fixed at 60° to each other, the angle of intersection being horizontal and normal to the plane containing the axial reflected ray. If the telescope objective is then arranged with its axis inclined 30° to the vertical, it will receive light from a star about 60° altitude along two paths: the first after reflection from the mercury surface and transmission, through the glass of one mirror; the second, after reflection from each mirror surface. Advantages are expected on account of the homocentricity of the two luminous periods, the augmented definition, and the possibility of constructing large instruments at moderate prices. C. P. B.

1403. *Coudé Spectrograph at Vienna.* **A. Hnatek.** (Zeitschr. Instrumentenk. 34. pp. 65–71, March, 1914.)—A powerful prism spectrograph has been adapted to the Coudé equatorial of the University Observatory at Vienna. The collimator is 1007 mm. focal length, and the camera is provided with two objectives of 300 and 580 mm. focal length respectively. An interesting description is given of the special method of suspension for securing rigidity and adaptability to adjustment with the optical axis of the main telescope, the whole spectrograph being suspended from strong girders near the roof of the observing chamber. The observation programme includes the determination of the radial velocities of 200 stars down to magnitude 6·0, contained in the zone between the pole and 60° North Declination. C. P. B.

1404. *Lateral Dark-ground Illumination.* **G. Guglielmo.** (Accad. Lincei, Atti, 23. pp. 432–488, March 15, 1914.)—Describes a spherical and a conical condenser specially suitable for physical (including Brownian motion) observations as distinct from biological studies. E. E. F.

1405. *Doppler's Principle for Light.* **C. Fabry and H. Buisson.** (Comptes Rendus, 158. pp. 1498–1499, May 25, 1914.)—Describes an ingenious method of readily demonstrating the above principle by means of a rotating disc of white paper illuminated by a Cooper Hewitt lamp placed at a distance of one diam. from the centre of the disc. By this means the edges of the disc always receive light travelling perpendicular to their direction of motion, and so act as sources of light identical with that of the lamp. These two sources are travelling at a high speed in opposite directions and the light from each in turn may be made to illuminate an interferometer. The size of the rings is observed to alter by an amount differing from the calculated value by only a few per cent., and the authors consider that by some experimental refinements, particularly the use of photographic records, the method might be employed to measure the velocity of light. J. W. T. W.

1406. *Dispersion and Absorption by Selenium.* **K. Foersterling and V. Fréedericksz.** (Ann. d. Physik, 43. 8. pp. 1227–1234, April 16, 1914.)—Highly polished mirrors of metallic and of amorphous selenium were obtained by casting on plates of carefully cleaned plate glass. The values for

$n^2(1-\kappa^2)$ and $2n^2\kappa$ were found and compared with those demanded by Drude's electronic formulæ. It was found that free electrons have no influence, and that n_0^2 is sensibly independent of λ in both modifications, but slightly greater in the amorphous modification. The curves obtained indicate the existence of two proper oscillations, of 317 and 500 $\mu\mu$ respectively, common to both modifications, but with a larger number of oscillating electrons in the case of the metallic Se. The essential difference is, however, the presence of a third proper oscillation in the metallic Se, of wave-length 592 $\mu\mu$. E. E. F.

1407. *Selenium Photometry.* **E. Carlo.** (Rev. Électrique, 21. p. 357, April 3, 1914. Communication to the Congrès de l'Assoc. Franç. pour l'Avancement des Sciences, Tunis, 1913.)—Proposes to measure candle-powers by means of the deflection of a galvanometer in series with a selenium preparation illuminated by the light to be measured. If monochromatic light is used, and the precaution is taken of illuminating the selenium for half an hour by means of a 50-c.p. lamp before each measurement, consistent deflections are obtained for each intensity of illumination. E. E. F.

1408. *Ponderomotive Couple at a Source of Light and Electron Impulse Theorem.* **P. S. Epstein.** (Ann. d. Physik, 44. No. 4. pp. 593–604, June 4, 1914.)—Mathematical discussion of the views recently put forward by K. Schaposchnikow as to this couple and its connection with the Poincaré-Abraham impulse theorems from which the following conclusions are drawn:—(1) The difficulties found by Schaposchnikow spring from the fact that he uses a statement of the impulse theorem unsuited to the case under consideration. (2) The calculation gives a complete accordance between the resulting couple and the electromagnetic turning impulse in the sense of Abraham's theorem. (3) The seat of the electromagnetic turning impulse is the diffraction waves emerging from the crystal, as already supposed by Ehrenfest. [See Abstracts Nos. 1672 (1909) and 849 (1914).] E. H. B.

1409. *Spectrophotometric Study of Absorption, Fluorescence, and Surface Colour of Magnesium Platinocyanide.* **F. G. Wick.** (Phys. Rev. 3. Ser. 2. pp. 382–395, May, 1914.)—This paper does not lend itself to abstraction. The dichroic transmission, dichroic fluorescence, and surface colours of magnesium platinocyanide are investigated using a Lummer-Brodhun spectrophotometer. The relation of fluorescence and surface colour to transmission, the transmission of polarised light through sections cut perpendicular and parallel to the optic axis are studied. T. H.

1410. *Measurement of Reflecting Power and Determination of Optical Constants.* **J. Koenigsberger.** (Ann. d. Physik, 43. 8. pp. 1205–1222, April 16, 1914.)—A continuation of previous work [see Abstract No. 1377 (1904)]. The reflecting power of various substances was determined, including quartz, calcspar, galena, specular iron ore, antimonite, platinum, black matt paper, black velvet, soot, and a Brashear mirror. Various wave-lengths were employed, ranging from λ7000 to λ4180. Application is made to the determination of the refractive index from measurements of the reflecting power in two media. A. W.

1411. *Exaltation of the Magnetic Double Refraction of Fresh Bravais' Iron by Means of Acid.* **A. Marchetti.** (N. Cimento, 6. Ser. 6. pp. 418–426, Dec., 1913.)—The author has extended Tieri's work on the action of acid on recently prepared Bravais' iron solution [Abstract No. 1421 (1910)], use being made of the experimental arrangement previously described [Abstract No. 1066 (1913)], the liquid being, however, illuminated with white instead of monochromatic light. The sample of Bravais' iron solution employed was prepared later than 1908 and exhibited an initial double refraction of about 8/100 of a wave-length in a field of about 14,650 units with a thickness of 8 mm. The variation of the double refraction with the time was examined in solutions of the iron containing different proportions of hydrochloric acid. The curves all follow similar courses, first rising rapidly to a maximum, and then falling gradually and becoming almost parallel to the time axis. The action of the acid thus produces an ageing of the iron similar to that which takes place spontaneously after the lapse of some years. It is evident that the formation of positive granules predominates in the early stages of this process, then proceeds less rapidly than, and subsequently at the same rate as, that of the negative granules. Finally, the negative granules begin to prevail over the positive ones and thus cause gradual diminution of the double refraction, which in time assumes a negative sign. T. H. P.

1412. *Determination of Emissive Power in the Infra-red.* **M. Drecq.** (Comptes Rendus, 158. pp. 1019–1022, April 6, 1914.)—For the purpose of determining emissive powers in the infra-red the author used a fluorine prism with curved faces as previously described by Féry [Abstract No. 536 (1910)]. Again, following Féry [see Abstract No. 861 (1909)], he used as receiver an angular surface, in conjunction with a thermopile. A piece of silver-foil 0·025 mm. thick was bent into a **V**-shape of angle 60°, and to the four corners were soldered wires of Bi 4 mm. long and 0·1 mm. diam. To the middle of the edge was soldered a silver wire 0·02 mm. diam. and 9 mm. long. The foil was covered with acetylene black, which possesses the lowest reflective power for the different wave-lengths. The receiving surface was 1 mm. wide and 8 mm. long. The arrangement as above described constitutes the hot junction, the cold junction being at the walls of a copper tube supporting the system. Connected to a galvanometer of 1·4 ohms resistance the element has a sensibility greater than that of thermo-elements recently constructed [see Abstract No. 927 (1911)]. Use has been made of the arrangement to obtain the energy spectrum of a black body at 1393°, and of a Nernst lamp taking 53·58 watts. For a black body the author used a piece of Pt-foil 0·05 mm. thick, rolled into a cylindrical shape 9 mm. diam. and 50 mm. long, a gap being left 1 mm. wide. This is heated by an alternating current, and with 100 amps. at 8 volts a temperature of 1600° is reached very quickly. A. W.

1413. *Light Propagation in a Dispersive Medium.* **A. Sommerfeld.** (Ann. d. Physik, 44. 2. pp. 177–202, May 12, 1914.)—Deals mathematically with the problem, distinguishing between phase velocity and signal velocity (or group velocity). [See Abstract No. 284 (1908).] E. H. B.

1414. *Scattering of Light.* **L. Brillouin.** (Comptes Rendus, 158. pp. 1331–1334, May 11, 1914.)—Mathematical paper dealing with the scattering of light by a transparent homogeneous substance on the theories of Planck, Einstein, and Debye. E. H. B.

1415. *Variation of Titanium Furnace Spectrum.* **A. S. King.** (Astrophys. Journ. 39. pp. 139–165, March, 1914.)—Several papers have previously been published by the author showing the remarkable differences which may be produced in the relative intensities of the spectrum lines of titanium as given by different sources of electrical energy [see Abstracts Nos. 60 (1909); 1655, 1817 (1913)]. In the present paper an analysis is made of photographs taken of the spectrum of Ti volatilised in the electric furnace at three stages of temperature from 2000° to above 2600° C. The results show the approximate temperature at which a line appears, and its rate of growth in intensity as the temperature increases. An important conclusion is that, aside from the enhanced lines, almost the entire series of Ti *arc* lines are also given in the high-temperature furnace spectrum. Several excellent photographs of selected regions of the spectrum are given to show the variations of special prominence. C. P. B.

1416. *Series Spectra and the Quantum Hypothesis.* **J. Stark.** (Deutsch. Phys. Gesell., Verh. 16. 6. pp. 304–306, March 30, 1914.)—From consideration of the Zeeman-effect, in connection with the recently observed electrical effect on spectrum lines, it results that the max. speed of electrons when emitting spectral series is below 200,000 cm./sec. The energy emitted by a radiating electron would then be below $1{\cdot}8 \times 10^{-17}$ erg, or some 100,000 times smaller than Planck's energy-quantum. Einstein's "light-cell" hypothesis also suffers in this connection. Considerations of the dimensions of the intra-molecular field of force in connection with the observed broadening of the series lines lead to the conclusion that the number of waves excited by a single impact is at least 1000. The "light-cell" must therefore have a length which greatly exceeds the wave-length, a conclusion which H. A. Lorentz (1910) deduced from considerations of interference. This deprives the light-cell hypothesis of its constructional and heuristic value, and the author, who formerly favoured it, is inclined to look for some other explanation of the observations which seemed to support it. E. E. F.

1417. *Lead Pencil Comparison Spectrum.* **J. Lunt.** (Cape of Good Hope Observatory, Ann. 10. Nature, 93. p. 251, May 7, 1914. Abstract.)—For the study of many terrestrial and celestial spectra it is often necessary to arrange for a comparison spectrum capable of furnishing certain standard lines for the reduction. A convenient source for this has been found in the graphite of an ordinary lead pencil, which generally contains sufficient impurities to give lines of iron, titanium, vanadium, chromium, barium, strontium, calcium, and often gallium, scandium, yttrium, silicon, magnesium, manganese, in addition to the carbon. C. P. B.

1418. *Variations of Arc Spectrum.* **M. Hamy** and **Millochau.** (Comptes Rendus, 158. pp. 1085–1086, April 20, 1914.)—In obtaining the arc spectrum of various elements when using the alternate-current arc, it was found necessary to vary the exposure time considerably owing to the changes of voltage of the supply current. An approximate formula is given to indicate the variations found. C. P. B.

1419. *Effect of Electric Fields on Spectrum Lines.* **O. M. Corbino.** (Accad. Lincei, Atti, 23. pp. 238–240, Feb. 15, 1914. N. Cimento, 6. Ser. 6. pp. 449–451, Dec., 1914.)—In connection with the electric decomposition of spectrum lines discovered by Stark [Abstract No. 238 (1914)], the author looked for an anomalous double refraction near the lines by sending light through an auxiliary arc. But no such effect was observed. E. E. F.

1420. *Spark Spectra of Elements in Extreme Ultra-violet.* **L.** and **E. Bloch.** (Comptes Rendus, 158. pp. 1416–1418, May 18, 1914.)—A continuation of previous work [see Abstract No. 1067 (1914)]. Measurements are extended to As, Sb, Sn, Bi, Al, and Cd. The lines have been mapped in general between 2100 and 1850 Å. C. S. G.

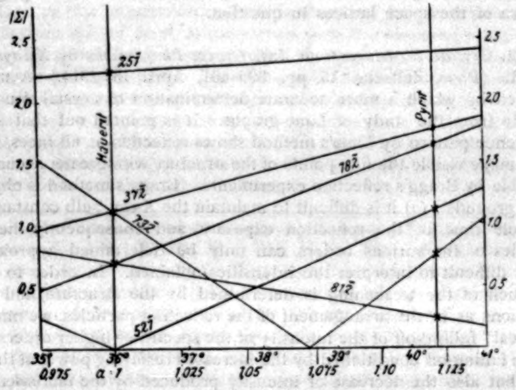
1421. *Interference of Röntgen Rays.* **R. Glocker.** (Phys. Zeitschr. 15. pp. 401–405, April 15, 1914.)—The author gives a further account of some experiments made on the transmission of X-rays through crystals [Abstract No. 878 (1914)]. The crystals investigated in the present instance were those of KBr, NaCl, and KCl. A direct experimental estimation of the ratio of the lattice constants for crystals of KBr and NaCl (*i.e.* the ratio of the lengths of the sides of the elementary cubes of the crystals) gave a value 1·15 for the ratio, and this was found to be in close agreement with the value obtained on the assumption that a crystal of KBr behaves as a face-centred cube. The author discusses the possibility of a "molecule" space lattice in the case of NaCl and KBr, but comes to the conclusion, from analogy with KCl, which demands an "atom" space lattice, that the lattice points of crystals of KBr and NaCl are also beset with atoms and not molecules. All the results are in complete accord with the view taken by W. H. and W. L. Bragg of the structure of the space lattices in question. E. A. O.

1422. *Crystal Structure from Interference Photographs by X-rays.* **P. P. Ewald.** (Phys. Zeitschr. 15. pp. 399–401, April 15, 1914.)—A method is described by which a more accurate determination of crystal structure can be made from the study of Laue-graphs. It is pointed out that since the interference pattern by Laue's method shows reflection at all faces, it is suitable to make visible the fine points of the structure with greater accuracy than is possible by Bragg's reflection experiments. Bragg's method is objected to on two grounds: (*a*) it is difficult to maintain the X-ray bulb constant during the whole time of the reflection exposure, and consequently the relative intensities of the various orders can only be determined approximately; (*b*) it is difficult to interpret the intensities obtained. In order to estimate how much of the weakening is determined by the structure, and to draw conclusions as to the arrangement of the reflecting particles, we must know the "ideal" falling-off of the intensity of the spectra of higher orders, *i.e.* not only the falling-off conditioned by the increased resolving power at the higher orders, but also the decrease of intensity produced by the increased coarseness of the surfaces on account of heat motion. This "ideal" falling-off of the intensity is different from crystal to crystal, and cannot be calculated beforehand without a knowledge of the structure and thermal properties of the crystal. It is pointed out that in Bragg's experiments no difference is made between rock-salt and pyrites in this respect, and thereby an error is introduced into the calculation of the structure. In the present method it is assumed that the type of the crystal grating is already known. The intensities of the spots of the interference patterns depend partly upon the wave-length and partly upon the more or less good superposition of effects due to the various elementary space gratings out of which the structure is built up. The amplitude of an interference ray is given by the structure factor Σ, which arises from the fact that the interference maxima of the single space gratings have a particular phase-difference. The variation of intensity between neighbouring wave-lengths caused by the structure factor of a complicated grating can be very large. In fact, in the case of a hemihedral interference pattern (*e.g.* pyrites), the hemihedral spots have various intensities simply on account of the factor Σ, although their wave-lengths, absorption, etc., are identical.

If now there is only one parameter of the structure unknown, then for a few chosen spots of the same or neighbouring wave-lengths the variation of Σ with the parameter can be determined, and we can then determine with ease that value of the parameter which best explains the intensities. In the case of pyrites, Bragg finds that the distance between the sulphur atoms is ⅕ that between the iron atoms. A consideration of the intensities of the various spots, however, shows that this ratio is incorrect. If we consider a more general system whose distance ratio is $a/5$, then the structure factor for spots with mixed indices is given by:

$$\Sigma = (-1)^{h_3} \cos\frac{\pi}{5} \cdot a\,(h_1-h_2-h_3) + (-1)^{h_1} \cos\frac{\pi}{5} \cdot a\,(-h_1+h_2-h_3) + \\ + (-1)^{h_2} \cos\frac{\pi}{5} \cdot a\,(h_1-h_2+h_3) + (-1)^{h_1+h_2+h_3} \cos\frac{\pi}{5} \cdot a(h_1+h_2+h_3).$$

Taking two spots with like wave-lengths, such as 25$\bar{1}$ and 52$\bar{1}$, if the indices are put into the above formula for Σ, we can get the values of Σ for various values of a. In the Fig. the absolute value of Σ is plotted as a function of a. This Fig. shows clearly how the intensity of 52$\bar{1}$, which is about ¼ that of 25$\bar{1}$, is nil when $a = 1$, but for larger values of a it approaches the correct value, viz. $\Sigma_{521} = \frac{1}{2}\Sigma_{251}$. When a is given values between 1·10 and 1·125, we obtain values of Σ which best explain the intensities, hence it is concluded that the true value of a lies between 1·11 and 1·125, and that likewise the distance ratio is not ⅕ but about 1·12/5.



The crystal hauerite is also discussed. E. A. O.

1423. *Debye-effect.* **E. Schrödinger.** (Phys. Zeitschr. 15. pp. 497–503, May 15, 1914.)—A theoretical discussion which establishes the following points:—(1) The interference pattern of a grating line does not depend on the edge conditions provided the number of points is sufficiently large. (2) Hence the intensity of the interference pattern is markedly affected only by such pairs of atoms as are not too far apart. (3) Theory indicates a diminution of the photographically observed intensity, and its final disappearance with rising temperature, as accords with experiments. [See Abstracts Nos. 1963 (1913) and 680 (1914).] E. H. B.

1424. *Secondary X-rays.* **J. Laub.** (Phys. Zeitschr. 15. pp. 842–844, April 1, 1914.)—A continuation of previous work [see Abstracts Nos. 677 and 868 (1914)]. Röntgen rays were sent through a lead tube 5 cm. long, 8 cm. wide, and 0·7 cm. thick, and were allowed to fall on a piece of sheet zinc 6 cm. long, 2·9 cm. wide, and 0·6 mm. thick, placed at the end of the lead tube. Thus the rays leaving the end of the tube chiefly passed through the zinc, but part emerged through the segmental slits at the sides. Behind the zinc sheet were three photographic plates, the distances being as follows:—Antikathode to zinc 85 cm., zinc to plate (i) 2 cm., zinc to plate (ii) 8 cm., zinc to plate (iii) 14 cm. The plates when developed showed distinct images of the slits, and also, round these, secondary images similar to the first but not so intense. Photographs are reproduced and the results discussed. A. W.

1425. *The Passage of α-Particles through Hydrogen.* **E. Marsden.** (Phil. Mag. 27. pp. 824–880, May, 1914.)—On the nucleus theory of an atom Rutherford and C. G. Darwin have recently discussed the relative motions of an α-particle and the nucleus of an atom in an intimate collision [see Abstracts Nos. 1081 and 1082 (1914)]. In the case of an encounter of an α-particle of velocity V with the nucleus of a hydrogen atom, if the latter is projected in a direction making an angle θ with the original direction of the α-particle, then the velocity of the "H" particle is given by $u = 1{\cdot}6\,V\cos\theta$. From Bohr's formula for the "velocity curve" of a charged particle, it can be deduced that in an end-on collision, *i.e.* $\theta = 0$, the "H" particle will have about four times the range of the α-particle producing it. Consequently, in the passage of α-particles through hydrogen the "H" particles may be looked for well beyond the range of the ordinary α-particles, and in the experiments to be described evidence of their existence has been found. More detailed experiments are in progress to investigate whether the distribution of their velocities, and relative motions with regard to the α-particles producing them, is in agreement with the calculations from the simple assumptions. The apparatus used consists of a wide tube about 1 m. in length and 9 cm. in diam., closed at one end by a zinc-sulphide screen, and at the other by a glass plate on a ground flange. A source of about 25 millicuries of radium emanation contained in an α-ray tube was mounted inside a sheet-iron cylinder so that it could be moved along the tube by a hand electromagnet. The tube was filled with hydrogen at atmospheric pressure, and scintillations were counted on the zinc-sulphide screen for different distances between source and screen. The results show that, in hydrogen, particles capable of producing scintillations are produced which can travel at least 8½ times as far as the α-particles. An experiment is described which shows that these particles are actually generated in the hydrogen. An experiment is also made to throw some light on the direction of projection of the H-particles. The scintillations produced by the H-particles differ little from those produced by α-particles except that they are not so intense; the luminosity of the screen due to the β- and γ-rays from the source is considerable. Further, the counting is made more difficult owing to the small rate at which the H-particles can be made to strike the screen, due to the large distance of the source necessitated by the long range of the α-particles. Experiments are therefore made in hydrogen at high pressure so that the α-particles have a smaller range, and by placing the apparatus in a strong magnetic field the β-rays are prevented from striking the screen. The method is somewhat unsuitable for a determination of the number of H-particles produced by a given number of α-particles of known velocity, since α-particles of all velocities are present, and, further, the minimum velocity at which a H-particle will produce a visible scintillation is a matter of conjecture. However, the number actually observed is about that to be expected from calculations on Darwin's formula, making reasonable assumptions for the difference between the theoretical and experimental conditions. A more convenient method of making a comparison between theory and experiment is furnished by the use of a thin film of some substance rich in hydrogen, such as paraffin wax or indiarubber. When α-particles fall on such films, H-particles may be expected to be ejected, and experiments have shown that this is actually the case. The observations are at present being continued so as to study the distribution and number of ejected H-particles when a parallel beam of α-particles of known velocity passes through these films. A. E. G.

1426. *Distribution in Intensity in the Magnetic Spectrum of the β-Rays of Radium (B + C).* **J. Chadwick.** (Deutsch. Phys. Gesell., Verh. 16. 8. pp. 383–391, April 30, 1914. Communication from the Physikal.-Techn. Reichsanstalt.)—The pencil of β-rays from a fine source of Ra(B + C) was deflected in known magnetic fields and the distribution in intensity in the magnetic spectrum investigated, both by direct counting [see Abstract No. 1873 (1913)] and by an ionisation method. The results showed a continuous spectrum, with a line spectrum of relatively very small intensity superposed. In the region of slow velocities a few stronger lines were found. These results appear to contradict those obtained by the photographic method [Abstract No. 251 (1914)] which seemed to lead to the conclusion that the β-rays of most radio-active substances are emitted in homogeneous groups. The difference between the results of the electric and photographic methods may be explained by the extremely great sensibility of the photographic plate for slight variations of intensity. E. M.

1427. *Relative Ionisation in Various Gases by β-Rays of different Velocities and the Ionisation produced by γ-Rays.* **R. D. Kleeman.** (Cambridge Phil. Soc., Proc. 17. 4. pp. 314–320, Jan., 1914.)—A beam of heterogeneous β-rays was obtained by placing a quantity of Ra at one of the entrances of a bore-hole passing through a thick lead block. The beam was allowed to pass into an ionisation chamber where the relative ionisation in methyl iodide, hydrogen, and air were measured. By means of a magnetic field the rays could be hardened to any extent by bending some of the slower rays aside. It was found that this process produced no change in the relative ionisations, showing the latter to be independent of the velocity of β-rays.

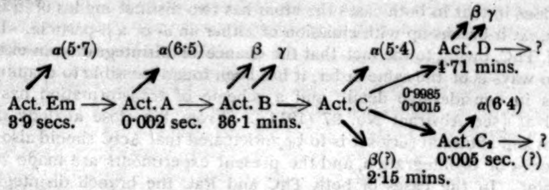
The author next discusses the bearing of these results on the process of ionisation by γ-rays, since it is known that the relative ionisation of the above gases differs largely when γ-rays of different penetrating power are used. It is concluded that these latter differences are closely connected with the secondary γ-radiation excited in the walls of the ionisation chamber used. E. M.

1428. *Distinction between the Penetrating γ-Radiation of Mesothorium and Radium.* **O. Hahn.** (Le Radium, 2. pp. 71–74, March, 1914.)—It is well known that mesothorium is chemically non-separable from radium, so that commercial mesothorium obtained from monazite sands generally contains of the order of 20 % of Ra. Estimations of the relative amounts of Ra and Meso-Th in a specimen are easy by the emanation method, but this involves breaking the containing tube. The author has made careful measurements of the absorption by lead of the γ-rays of various preparations with a view to distinguishing them by this method. The preparations used were :—(1) $RaBr_2$, pure. (2) Commercial mesothorium freshly prepared. (3) Commercial mesothorium, 2 years old [*i.e.* having grown radio-thorium]. (4) Freshly prepared mesothorium, free from Ra. (5) Radio-thorium. The electroscope used was of lead with walls 3·3 mm. thick, and the following relative ionisations were obtained :—

Mm. Lead.	(1) Radium.	(2) Mesothorium (New).	(3) Mesothorium (Old).	(4) Mesothorium (without Ra).	Radio-thorium.
3·3	100	100	100	100	100
5	84·5	86·7	85·5	87·8	86·5
10	57·6	60·7	60·1	60·8	63·1
15	41·9	44	44·6	43·2	47·1
20	31·5	32·1	33·2	31·5	36·8
25	24·2	23·7	25·2	22·8	29·1
30	18·6	17·7	19·4	16·7	23·3
35	14·3	13·4	15·5	12·2	18·8
40	11·3	9·9	11·8	9·2	13·8
45	9·0	7·5	9·1	6·8	12·4

E. M.

1429. *Transformations in the Active Deposit of Actinium.* **E. Marsden** and **P. B. Perkins.** (Phil. Mag. 27. pp. 690–703, April, 1914.)—It is well known that the "C" products of the active deposits of Ra and Th are anomalous in that in both cases the atom has two distinct modes of transformation, *i.e.* it breaks up with emission of either an α- or a β-particle. In the case of ThC, owing to the fact that the chance of disintegration in either of the two ways is of the same order, it has been found possible to examine the process in considerable detail, and a scheme of transformation has been arrived at [see Abstract No. 97 (1914)]. From the close analogy of the thorium and actinium series it is to be anticipated that ActC should also show two modes of disintegration, and the present experiments are made to test this point. In the cases of both ThC and RaC the branch disintegration involves the emission of a long-range α-particle, 8·6 cm. in the former case and 6·94 cm. in the latter. Further, with the whole series of products in equilibrium, the total number of α-particles of the two ranges emitted by the "C" products is equal to the number from the emanation and "A" products on the main series. From the experiments of Geiger such a result must also hold for ActC if a branch occurs in this product. Experiments are consequently made to test whether any long-range α-particles are emitted from ActC, the general evidence indicating that the number of such particles must be small compared with the number of range 5·4 cm. which constitute the main radiation. The simplest method of making such an experiment would be to take a source of actinium active deposit, and to count the scintillations on a zinc sulphide screen placed in air at different distances from it. Such an experiment had already been tried by Geiger, and it is now repeated without finding any α-particles beyond 5·4 cm. However, with the sources of actinium available, the number of α-particles falling on an area of 1 sq. mm. (the area of the field of the microscope) at distances greater than 5 cm. is very small. Consequently a sheet of mica, of air equivalent over 5 cm., was interposed between the source and screen so that a smaller distance between the two could be used. The experimental arrangement is shown. The α-particles from the source A passed through a sheet of mica B and impinged on a zinc-sulphide screen Z, where the scintillations were observed by a microscope M. The distance of A to Z could be varied in different experiments, and was generally between 0·9 and 1·5 cm. The thickness of mica was also varied in different experiments between 5 and 7 cm. air equivalent. Curves for ActC, RaC, and ThC_2 respectively are given. The curve for ActC differs from the others, and indicates that about 0·15 % of the particles can penetrate much further than the ordinary *α*-particles of range 5·4 cm. The range of the new *α*-particles or the range at which scintillations cease to be produced is about 6·4 cm. The absence of RaC in the source is proved, so that the above experiments indicate that the *α*-particles of ActC are complex, and that 0·15 % have a range of 6·4 cm., while the main number have a range of 5·4 cm. The ionisation curves of *α*-particles from Po, ActC, RaC, and ThC are also investigated. It can be at once observed from an inspection of the figure given that the different curves are not superposable : for instance, the distance between the maximum and the end of the range is least for Po and greatest for ThC_2. As the *α*-particles of ActC and RaC have ranges intermediate between those of ThC_2 and Po, it is to be expected that the curves should show intermediate characteristics. The results are in general agreement with this expectation. The experimental curves are, however, almost identical ; whereas theoretically the actinium curve should be nearer to that for Po, since the range of the *α*-particles of ActC is smaller than the range of the *α*-particles of RaC. By analogy with the transformations in the active deposits of thorium and radium, the actinium active deposit may be written as follows :—



In a table the disintegration constants and properties of the products following the emanations are given. The *α*-rays are characterised by their ranges in air at 15° C. and 76 cm. Hg, and the *β*-rays and *γ*-rays by their respective absorption coefficients in Al, the numbers for *γ*-rays being taken from the tables of Rutherford and Richardson. In almost every column the Th product lies intermediate in its characteristics between the corresponding products of Ra and Act. No direct information is at present available as to whether this is also the order of the atomic weights. An exception occurs in the "B" products, the transformation constants and the absorption coefficients of the hardest *γ*-rays following the order Ra > Act > Th. Another exception is that the ranges of the particles of the C_2 products (= RaC′) follow the order Th > Ra > Act. **A. E. G.**

1430. *Decay of Radium Emanation in an Atmosphere of Helium.* **W. Marckwald.** (Phys. Zeitschr. 15. pp. 440–441, May 1, 1914.)—The experiments show that the activity of RaEm, as measured by *γ*-rays, decays at the same rate when helium is present as in presence of air. **E. M.**

HEAT.

1431. *Cooling of Spheres.* **F. Vercelli.** (N. Cimento, 6. Ser. 6. pp. 427–436, Dec., 1913.)—Two spheres of different substance but equal radius, cooled from the same initial temperature until they possess a given final temperature at the centre, have coefficients of thermal conductivity which are directly proportional to the density and specific heat, and inversely proportional to the time required for the cooling. The author describes a method governed by rigorous formulæ, and involving the use of elliptic functions. E. E. F.

1432. *Diffusion-coefficient of Gases and Viscosity of Gas-mixtures.* **J. P. Kuenen.** (Konink. Akad. Wetensch., Amsterdam, Proc. 16. pp. 1162–1166, May 29, 1914.)—A previous communication [Abstract No. 1248 (1913)] on the diffusion-coefficient, D, of gases showed that the contradiction between the theories of O. E. Meyer and Maxwell-Stefan-Langevin could be largely removed by taking into account in the former theory the persistence of molecular movement. On this improved theory a much smaller change in D with the composition of the mixture is involved, in contrast to the second theory mentioned which makes the coefficient entirely independent of composition. The author has now calculated D for two pairs of gases, namely carbon dioxide—hydrogen and argon—helium, which seemed specially suitable owing to the great difference in the molecular masses. A further modification to the formulæ has now to be given expressing the mutual attraction influence of the molecules. A difficulty arises here, since in the viscosity of a mixture not only the attraction of unlike molecules but also that between like molecules plays a part. If the observations could be represented by a rigorous theoretical formula the various attractions could be separated, but as this is not the case an estimation has to be made. The agreement between observation and calculation, viz. for CO_2 and hydrogen, 0·53 and 0·551 is very satisfactory, but for argon and helium 0·70 and 0·597 is less close. The viscosity of gas-mixtures is considered, and the ordinary gas theory found to give, without being strained, a maximum in the viscosity in accordance with observation—a result hitherto not explained. H. H. Ho.

1433. *Natural Radiation from a Gas.* **G. Green.** (Roy. Soc., Proc. Ser. A. 89. pp. 581–587, March 2, 1914.)—A mathematical investigation with the object of deriving a form of pulse in agreement with Planck's law of radiation at any temperature, and of discovering if any information can be obtained regarding the constitution of natural radiation by decomposing this pulse. The author arrives at a form of pulse which represents complete radiation at all temperatures, and the statistical relation between it and the harmonic constituents of the radiation emitted by the various groups of molecules. A fuller discussion is reserved for a later paper. E. E. F.

1434. *Quantum Effect in Monatomic Gases and Liquids.* **A. Eucken.** (Preuss. Akad. Wiss. Berlin, Ber. 22. pp. 682–693, 1914.)—Describes experiments on the compression, etc., of helium and hydrogen and theoretical deductions therefrom. It is concluded that the work is incompatible with the acceptance of a zero-point energy. [See Abstracts 632 and 1018 (1913).]
E. H. B.

1435. *Thermodynamic Equilibrium.* **I. Bródy.** (Ann. d. Physik, 44. No. 4. pp. 585–592, June 4, 1914.)—Mathematical discussion of thermodynamic equilibrium and its disturbance under general external conditions.
E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1436. *Measurement of* e/m *for Kathode Rays.* **L. T. Jones.** (Phys. Rev. 3. Ser. 2. pp. 317–324, May, 1914.)—This determination of e/m and v is by a modification of the usual method employing the simultaneous electrostatic and magnetic deflections. The modification is the result of an attempt to eliminate as nearly as possible the errors of measurement of the deflections and the correction due to the field distribution at the ends of the electrostatic plates. This is brought about chiefly by the position in which the photographic plate was placed, viz., on the lower electrostatic plate, the kathode rays passing at grazing incidence along the upper electrostatic plate; the two plates being mounted at 1 cm. apart. Thus the fields were uniform over the entire path of the deflected kathode beam and its deflection was constant for all fields.

The mean of twenty successive photographs gave $e/m = (1{\cdot}75 \pm 0{\cdot}03) \times 10^7$.

E. H. B.

1437. *Possible Union of the Electromagnetic and Gravitational Fields.* **G. Nordström.** (Phys. Zeitschr. 15. pp. 504–506, May 15, 1914.)—A mathematical paper in which it is shown that a single treatment of the electromagnetic and gravitational fields is possible if one regards the four-dimensional space-time world as a surface of a five-dimensional world. [See Abstracts Nos. 7 and 1191 (1914).]

E. H. B.

1438. *A Comparison of the Electrical Conditions of the Atmosphere at Kew and Eskdalemuir, with Notes on Observations of Atmospheric Electricity made in Other Countries.* **G. Dobson.** (Meteorolog. Office, Geophysical Mem. No. 7. pp. 155–169, 1914.)—Potential gradient is the only electrical element which is recorded continuously at either of the two observatories. For this purpose a "water-dropper" type of instrument is used. To obtain mean figures 10 quiet days per month have been selected and tabulated at Kew, but owing to the more disturbed record obtained this method could not be used at Eskdalemuir. Accordingly two methods were adopted here: first all "O, a" days were taken, that is, days which gave no negative gradient and throughout which the potential was steady, and second, all "complete ordinary" days were used, that is, all days were omitted on which the potential was so unsteady that the curve left the paper at any time during the day. Owing to the much greater number of days obtained by the second method it is preferred to the first for getting mean results, but in most cases results by both methods are given. The winter type of diurnal variation is very similar at Kew and Eskdalemuir, but in summer there is a marked difference, the potential at Eskdalemuir maintaining a steady and fairly high value during the night hours, while Kew shows a well-marked minimum at 4 a.m. The type of the annual variation is similar at both observatories, but the range is decidedly smaller at Eskdalemuir. The mean potential gradient is also smaller here and amounts to not much more than two-thirds of the value for Kew. In considering the results for conductivity and the number of ions in the air considerable differences appear at the two stations.

In particular the ratio of the number of positive to negative ions (*q*) shows a large annual variation at Eskdalemuir, but is almost constant at Kew. The conductivity, on the other hand, has a well-marked variation at Kew not shown at Eskdalemuir. It is found that this annual variation of conductivity is almost entirely due to a variation in the number of ions and not to any change in their mobilities. Results from certain foreign stations are also given for comparison. J. S. Di.

DISCHARGE AND OSCILLATIONS.

1439. *On the Conditions of the Variable Influence of Light upon the Spark, and on the Means of Regulating Sparks.* **M. Bonch-Bruevich.** (Russian Physico-Chemical Soc., Journ. 45. 8. pp. 481–458 [Physical Part], 1914.)—In reviewing the experiments of Lebedinski and Mitkiewicz with the direct rays of an arc upon the spark-gap, the variable nature of the effects produced led the author to the idea that in the spark itself, under the influence of the light, two completely opposing processes arise. The task of regulation of the spark, with a view to obtaining at will the one or the other effect, then followed. Lebedinski and Mitkiewicz had indicated a method of procuring a "sensitive" spark, that is, one which would simultaneously suffer extinction under a strong, and ignition under a feeble, light. Commencing with a small distance, the spark-gap between a sphere (—) and a pointed rod (+) was gradually enlarged, observation being at the same time kept upon the effect of the light upon a thin spark. This effect, in the beginning, was that of sharply kindling the spark, and if the power of the light was diminished an enfeeblement followed. For a certain sufficiency of spark-length extinction was reached, and at this point the weakening of the light either kindled the spark or else produced an indeterminate effect. In the last case, when the spark was shortened, a point was reached when both phenomena could be clearly observed. To further investigate these and other effects the author, working in the physical laboratory of the Nikolaevski Engineering Academy, constructed the arrangement shown in Fig. 1 for obtaining the spark. The Oerlikon transformer (15,000 volts, 1 kw., transformation ratio 800) there shown is supplied with alternating current from a small converter. For regulation, either strength of current, or the periodicity (80–50), can be altered. V is a Weston voltmeter with scale permitting of ½-volt readings. It measures the pressure at the terminals at the primary, indicating at the same time the character and the relative magnitude of the change in the spark pressure resulting from various factors, and permitting of judgment as to alteration of pressure that occurs at the ends of the gaseous space. By means of this arrangement it has been possible to trace the mutual action between light and electrical discharge afforded by the change in the spark space. The source of radiation was a voltaic arc, in some experiments of 9–14 amps., and in others 80 amps. The arc was customarily placed at a

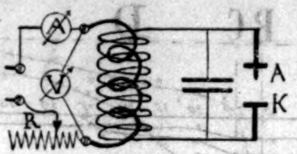


FIG. 1.

distance from the spark-gap of about 1 m. At the commencement of the investigations the author used for the positive electrodes steel needles of various thicknesses, but it became apparent to him that it was not the pointed form of a thin needle which actually affected the character of the phenomenon, as might be suggested on first thought, but that it was the change in the distribution of the lines of force of the field. Experiment showed that

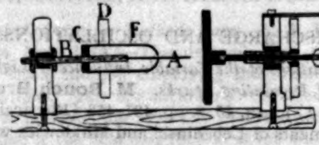


FIG. 2.

if a metallic disc of mushroom form were caused to slide along the needle with the curved face facing towards a spherical electrode, then according to the position of the disc it was possible to change the potential of discharge, also the form of the discharge, as well as the influence of radiation on the spark. So that what had been previously attempted by degrees of fineness of the electrode could now be secured by the application of a metallic disc of 1 cm. diam., keeping the electrode itself unchanged. Three positions of the disc correspond in effect to (1) a very blunt electrode (disc covering point); (2) a very sharp one (disc moved as far from point as possible).

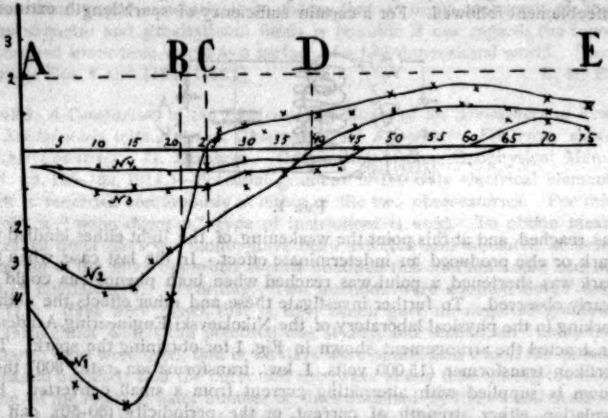


FIG. 3.

In the third position (disc in middle position) an effect was produced as if the needle A were gradually and continuously sharpened. With this appliance the author claims to be able to study what influence a change of length of the spark has upon this or that process while the electrode is virtually being varied in acuteness.

The latest form of the author's spark measure is exhibited in Fig. 2. On a brass screw-threaded spindle B, secured in an ebonite bushing, moves the ferrule C, which is itself fastened to the brass body F. Through an opening in F passes a thin gold needle A metallically connected to the spindle B. Gold is preferred owing to its merely gradual wear, and to its resistance to oxidation. The rubber disc D serves to turn the cylinder and to count revolutions: one revolution moves the cylinder 1 mm. The kathode is sometimes a brass disc and sometimes a sphere 1 cm. in diam. The investigations of the author are illustrated graphically. For instance, Fig. 3 shows the effects, respectively, of powerful and feeble radiations, while the position of the mushroom-shaped disc is varied, and consequently one effect passes over to the other. Fig. 4 exhibits the effects when the arrangement of Fig. 2 is employed and the position of regulator F is altered.

'The pitches of the screw-threads of the regulators for Figs. 3 and 4 differ, but the scale of the drawing is the same for both.

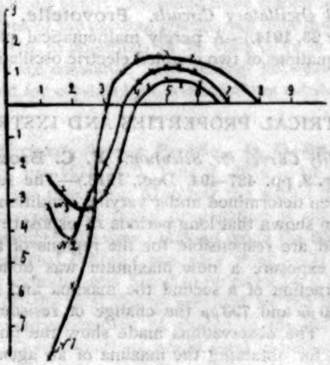


FIG. 4.

For the graph of Fig. 3 the kathode employed was a sphere 1 cm. in diam., and in the case of that of Fig. 4 it was a brass disc 3 cm. in diam. Diminishing the surface of the kathode, without altering the nature of the phenomenon, increased the distance between the points of inversion of the effect, giving a chart akin to that of Fig. 3. Increase in this distance is also obtained by shortening the spark, in which case the curves plotted are those of Fig. 4.

Comparison of the effects of two radiations of different intensity, for example in Fig. 3, that of a more powerful light, No. 1, and of a more feeble one, No. 2, shows that, in proportion to an increase in the sharpness of the anode, they exhibit the following relations:—(1) Space AB—radiation No. 1 kindles the spark more intensively than radiation No. 2. (2) Point B—both radiations have an equal effect. (3) Space BC—radiation No. 1 kindles more feebly than radiation No. 2. (4) Point C—radiation No. 1 exhibits no effect, while No. 2 kindles. (5) Space CD—radiation No. 1 extinguishes, while No. 2 has still the opposite effect. (6) Point D—radiation No. 1 extinguishes; No. 2 exhibits no influence. (7) Space DE—both radiations extinguish, and in this case No. 1 is the more powerful in its effect. In the graphs the ordinates represent increase in volts (above), or decrease in volts (below), at the terminals of the primary coil of the transformer

(Fig. 1), brought about by the illumination of the spark-gap, and characterising the magnitude of its effect. The abscissæ relate to the number of revolutions of the regulator.

Many additional interesting facts are brought out by the author—such as those relating to the change of spark to arc, and to brush discharge, but for these reference must be made to the original paper. E. O. W.

1440. *Radiation of Electric Waves over Conductors and Semi-conductors.* **M. Sjöström.** (Jahrbuch d. Drahtlosen Telegraphie, 8. pp. 238–244, March, 1914.)—Discusses the theories of Sommerfeld and his school and the experiments of F. Erb. According to the latter attenuation of intensity is slower than $1/r^2$ for waves along plane metal surfaces, but faster than $1/r^2$ for waves along the surface of salt solutions. E. H. B.

1441. *Coupled Oscillatory Circuits.* **Provotelle.** (Lumière Électr. 25. pp. 647–651, May 23, 1914.)—A purely mathematical paper dealing with the solution of the equations of two coupled electric oscillation circuits. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1442. *Sensibility Curves for Selenium.* **F. C. Brown** and **L. P. Sieg.** (Phys. Rev. 2. Ser. 2. pp. 487–494, Dec., 1913.)—The sensibility curve for a Giltay cell has been determined under varying conditions. As is indicated by theory, it has been shown that long periods of exposure give varying degrees of complexity and are responsible for the regions of max. sensibility. By long periods of exposure a new maximum was obtained at 800 $\mu\mu$. By exposures of a fraction of a second the maxima and minima vanish, and between about 460 $\mu\mu$ and 790 $\mu\mu$ the change of resistance is independent of the wave-length. The observations made show the importance of defining simple conditions for obtaining the maxima of an agent whose action is so complex as is that of Se. In the Giltay cell studied the maxima as well as the minima arise from the slow rates of change. A selenium cell of this type on account of the independence of wave-length for short periods of exposure may turn out to be the most delicate instrument constructed for measuring energy within the range noted. J. J. S.

1443. *Peculiarities of Compressed Powders of Antimony, Bismuth, and Galena.* **G. Gehlhoff** and **F. Neumeier.** (Deutsch. Phys. Gesell., Verh. 15. 21. pp. 1069–1081, Nov. 15, 1913.)—The thermal and electric conductivity and also the thermo-e.m.f. per 1 deg. C. of compressed powders both of pure Sb and Bi and of Bi with small admixtures of Sb, were investigated. The specimens were examined at the temperatures —190°, 0°, and 100° and partially at —79°. Comparison is made with cast specimens at the various temperatures. The strong increase in heat conductivity with falling temperature observed in the case of specimens which have been fused, is much less marked with compressed powders. Mixed crystals are formed in only a small amount and the diffusion of the two metals into one another when the powders are mixed and pressed is very slow. The electric conductivity, especially of the compressed powders of the pure metals Sb and Bi, shows a distinct lessening in comparison with the cast metals. Pfleiderer's relation that thermal and electric conductivity decrease in equal proportion has no validity for mixed Sb and Bi. The earlier supposed relation that electric conduction finds smaller transition resistance than thermal conduction in compressed metallic powders is not established in the cases examined by the authors.

The result of the investigation shows that by means of the application of pressures up to 5000 kg./cm.^{2} it has not been possible to obtain, with those metallic powders whose melting-points lie comparatively low (especially in the case of Bi), compressed blocks in which the formation of mixed crystals has resulted and whose physical characteristics resemble to a certain degree those of the fused metals. J. J. S.

1444. *Propagation of Electricity through Paraffin Oil.* **G. G. de Villemontée.** (Comptes Rendus, 158. pp. 1414–1416, May 18, 1914.)—Oil of density 0·876 at 24° C. is placed between two concentric brass cylinders. The outer cylinder is maintained at a potential V, and the charge Q developed on the inner cylinder at various temperatures, t, is measured by a quadrant electrometer. The variations of Q/Vt are found to be similar at different times and for different durations of the exciting charge, and to be independent of the size of the cylinders. Up to potentials of 20 volts Q/Vt is represented by $ke^{b}t^{-a}$, where k, a, and b are constants. The analogy between the conduction of the oil and that found for crystals by Curie is further substantiated.

C. S. G.

1445. *Passage of Electricity through Paraffin.* **G. G. de Villemontée.** (Comptes Rendus, 158. pp. 1571–1572, June 2, 1914.)—In continuation of previous experiments [see preceding Abstract] the author describes investigations of the laws governing the initial propagation of electricity through paraffin oil. The following results were obtained when the time of duration, θ, of the charge on the external cylinder was very short :—(1) the total charge received on the inner cylinder was found to be given by $q_1 = ke^{b}\theta^{-1}$, k and b being constants, and (2) the total charge received by the inner cylinder at any time, t, from the commencement of charge of the outer cylinder was given by $q_2 = ke^{b}t^{-1}$. These equations would seem to indicate an extremely great initial charge on the inner cylinder. Other interesting results were obtained. Two condensers of different dimensions were used to examine the effect of dielectric thickness. For charges of very short duration the total charges, q_1, q_2, of the above equations were found to be the same with both condensers. For charges of longer duration this did not hold, and when the time of charge was comparatively great (1 hr. 44 mins.) the ratio of the charges obtained on the inner cylinders differed very little from the inverse ratio of the dielectric thicknesses in the two cases.

J. W. T. W.

ALTERNATING CURRENTS AND MAGNETISM.

1446. *Demagnetising Factors of Cylindrical Rods in High Fields.* **B. O. Peirce.** (Amer. Acad., Proc. 50. pp. 53–64, June, 1914.)—Magnetic measurements on long rods cut down between successive observations lead to the following conclusion. In properly constructed solenoids with uniform fields above 2500 gauss, rods only 25 or 30 diameters long may be safely used with the expectation of finding that the fluxes through their meridian sections are the same, within the limits of ordinary careful laboratory practice, as if the pieces were infinitely long. At low excitations the corrections for the ends of pieces as short as this would, of course, be very large. The magnetising solenoid should be about 25 diameters of its own coil longer than the test-piece. [See also Abstracts Nos. 118 (1906), 676 (1908).] G. E. A.

1447. *The Magnetic Properties of a Graded Series of Chrome Steels at Ordinary and Low Temperatures.* **M. B. Moir.** (Phil. Mag. 27. pp. 830–842, May, 1914.)—It is well known that the effect of raising the temperature of iron or steel is to increase its susceptibilty to magnetism for low values of the magnetising force and to diminish it for high values. It is to be expected then that, if the temperature of a test-piece be lowered, the effect should be exactly reversed, and the susceptibility should be diminished for low, and augmented for high fields. That such is actually the case has been shown for various magnetic materials by Honda and Shimizu [Abstract No. 395 (1906)], and more recently by Gray and Ross [Abstract No. 259 (1913)], who have all used the temperature of liquid air, —190° C., as the low temperature at which they have made their investigations. They have shown also that, while alike in this one respect, different materials differ very considerably both in the amount of change in susceptibility brought about by the change in temperature and in the value of the field strength for which the effect reverses its sign. In order to observe the effect of similar treatment on the different members of a graded series the magnetic properties at ordinary and low temperatures of a graded series of chrome steels were examined. The specimens were in the form of cylindrical rods 20 cm. long and 0·9 cm. diam., and the conditions in which they were tested were (1) forged and rolled, (2) annealed from 900° C., (3) quenched from 900° C. In the first condition the specimen is in a state of internal strain brought about by the treatment to which it has been subjected in the course of preparation, and is in general far from homogeneous. The effect of annealing the specimen from 900° is to remove the internal strains, and to bring it into a standard homogeneous condition. Specimens are examined containing 1 %, 4·05 %, 8 %, 12 %, 16 %, and 20 % Cr. The results obtained are given in tabular and graphical form, and may be summarised as follows:—The effect of lowering the temperature of a chrome steel is to diminish its susceptibility for low fields and to increase it for high fields. The crossing of the curves at 15° C. and at —190° C. in the annealed condition takes place for higher values of the magnetising force as the Cr-content is increased up to 12 %, but further additions after that point lower the value of the field for which crossing occurs. Immersion in liquid air produces a permanent effect on the annealed specimen, which is not wiped out when the temperature is allowed to rise to room-temperature again. For specimens in the quenched condition the crossing of the curves at 15° C. and —190° C. occurs for very high values of the magnetising force, probably much greater than 160 C.G.S. units. Immersion in liquid air has no permanent effect on quenched specimens; and in both annealed and quenched conditions the residual magnetism and the coercive force are greater at —190° C. than at 15° C. A. E. G.

1448. *Hall-effect in Flames.* **H. A. Wilson.** (Phys. Rev. 3. Ser. 2. pp. 375–381, May, 1914.)—From experiments by Marx on the Hall-effect in a Bunsen flame it appeared that the effect diminished as the conductivity of the flame increased, and varied with the nature of the salt sprayed into the flame. These results do not agree with the theory that the negative ions are electrons. The author gives a possible explanation of the discrepancy, and describes experiments which avoid the suggested sources of error. Current can be passed horizontally through a large flat flame in a direction perpendicular to the magnetic field in which the flame is placed. The Pt-electrodes are in the flame 9 cm. apart. The Hall-effect is measured by two horizontal Pt-wires, usually 1 cm. apart, connected to an electrometer. They are placed one above the other perpendicular to the flame, passing through it, fixed in a tube which, passing through a hole in the pole-face of the electromagnet exciting the field, is capable of rotation about a horizontal axis; the amount of rotation can be measured to 0·1°. With magnetic field off, the wires are turned until they are at the same potential, the electrometer being undeflected. With field excited, the wires are rotated through an angle θ until they are again at the same potential. Then $\tan\theta = X/Y$, where X and Y are the horizontal and vertical potential gradients in the flame. This ratio can be determined by one observation, knowledge of the electrometer sensibility being unnecessary.

The effect is independent of the current through the flame and hence of the horizontal potential gradient. It is also practically the same for flames with and without alkali metal salts. $\tan\theta/H$ is nearly constant, and the velocity of the negative ion per volt/cm. which by the usual theory is $10^8 \times X/HY = 10^8 \times \tan\theta/H = 2450$ cm./sec. Thus there seems no reason to doubt the conclusion that this velocity is the same for all alkali metal salts in a particular flame. T. H.

RADIOLOGY AND ELECTROPHYSIOLOGY.

1449. *Osmo-antikathodic Vacuum Regulator in Röntgen-ray Tubes.* **C. Regaud.** (Archives d'Él. Médicale, **22.** pp. 600–609, June 10, 1914.)—This is a modification of that of Villard and Chabaud, and, like it, is based upon the property possessed by a thin lamina of Pt, of becoming permeable to hydrogen when heated to a suitable temperature. The principle of the modification is as follows: The osmo-regulating lamina of Pt is arranged as an antikathodic plate or part of such a plate, the hydrogen being made to pass over the exterior surface of the Pt; the necessary rise in temperature of the Pt is obtained as the result of the impact of kathode particles. The arrangements for obtaining this end are described in two sections: (1) Different arrangements of the antikathodic Pt lamina and of the system for circulation of the gas. (2) The antikathode as an emitter of Röntgen rays and as an osmo-regulator. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1450. *Colloidal Solutions of Radio-active Substances.* II. **F. Paneth.** (Akad. Wiss. Wien, Ber. 122. 2a. pp. 1637–1651, Oct., 1913.)—The author has investigated the capability of dialysis, diffusion velocity, and direction of migration of several radio-active substances [see Abstract No. 580 (1914)], and it is shown that these properties depend on whether the observations are made in acid, neutral, or basic solutions. In acid solutions all dialyse with normal velocity, while in neutral and basic solutions the different radio-elements behave differently. The results show that polonium and RaE are colloids in neutral solution. ThB and RaD only begin to assume the colloidal state in ammoniacal solution, while Ra and ThX remain kathions in all cases. The colloid particles must be extremely small, an estimate of the molecular weight being 1600 in the case of Po and 460 in the case of ThB. The inclination to go into the colloidal state seems intimately connected with chemical nature. E. M.

1451. *Action of Colloids on Radio-active Products in Solution.* **T. Godlewski.** (Phil. Mag. 27. pp. 618–632, April, 1914.)—In a previous paper [Abstract No. 1017 (1914)] the author showed that the products of the active deposit of Ra in neutral, alkaline, or weakly acid solutions are in the colloidal state. It was also found that in acidulated solutions or in presence of polyvalent kathions the products were deposited at the kathode almost exclusively, while in presence of polyvalent anions the anode is activated on electrolysis. Anomalous results were obtained with RaC which in pure water solution appears to be deposited partly at the kathode and partly at the anode, although RaA appears at the anode only and RaB at the kathode. Further experiments appear to give the explanation. When the atom of RaC arises from the RaB the recoil is only feeble, RaB emitting only a β-particle. For this reason if one of the atoms in the aggregate RaB which forms the centre of a positive hydrosol is transformed into RaC, it will not escape from its environment of RaB atoms, but will be carried with them to the kathode. We may therefore expect that only those RaC atoms go to the anode which during their transformation manage to escape, and also those which belong to groups in which the majority of the RaB atoms have already undergone transformation. The author has also made detailed experiments on the influence of foreign colloids on the hydrosols of RaA, B, and C. The results show that the addition of a negative colloid arsenious sulphide or Pt in small quantity, causes the products deposited at the kathode to diminish in amount and afterwards to disappear, *i.e.* it produces the precipitation of colloids of opposite signs. Similarly, positive colloids (ferric oxide) when added in relatively small amount conduce to precipitation of RaA and RaC which are among negative colloids; in higher concentrations positive colloids absorb them, thus inverting their signs. It is further shown that radio-active products, when present as positive hydrosols, can be concentrated by simple filtration since those hydrosols are entrained by filter-paper owing to capillary action. E. M.

1452. *Combustion of Air in the Voltaic Arc.* **A. I. Gorbov** and **V. F. Mitkevitsch.** (Russian Physico-Chemical Soc., Journ. 45. pp. 1109–1136, 1918.)—The principal conclusions arrived at by the authors as a result of theoretical considerations and of experimental data obtained with a small Birkeland-Eyde furnace and with one of their own design, are as follows:—The relation between c, the percentage of nitric oxide formed on combustion of air under the influence of the voltaic arc, δ, the volume of air introduced into the furnace per hour per kw., and G, the number of gm. of nitric acid into which the nitric oxide may be transformed, is expressed by the equation $8G/225 = c\delta$...(1), which is similar in form and in the significance of its terms, to the Clapeyron gas equation, $RT = pv$. From this it follows that (1) if with a given air-supply the conditions of combustion are changed so as to maintain a certain definite percentage of nitric oxide, the number of gm. of nitric acid per kw.-hour will be the greater the less the number of kw. supplied to the arc, and (2) one and the same quantity of nitric acid per kw.-hour may be obtained with various concentrations of nitric oxide, if with constant arc-power and variable conditions of burning the percentage of nitric oxide changes in inverse proportion to the air-supply.

The general relationship between the air-supply and the percentage of nitric oxide in the issuing gas may be derived *a priori* on the assumption that the divergence of technical apparatus from the ideal is expressible as a certain air-supply to be applied as a correction to that actually used. The conclusion thence drawn is that, with the limits in concentration of nitric oxide as yet attainable in practice, this relationship is expressed by the hyperbolic formula $c = b/(\delta + a)$ ... (II). Writing b' for b/a, this gives $G = 225a(b' - c)/8$ ... (III) and $G = 225b\delta/8(\delta + a)$ ... (IV). These equations are regarded as general, and are probably applicable to the data obtained with any electric furnace. Comparison of equation (III) with the fact that a furnace may work with a constant yield of nitric acid, but with a variable percentage of nitric oxide, leads to the conclusion that, for each furnace, there is possible not a single equation of type (III), but a series of them corresponding with varying utilisation of the energy. In agreement with the observations of other investigators, it is found that the values of a'' and b'', a''' and b''', etc., for this series of equations exhibit a constant ratio, that is—

$$b''/a'' = b'''/a''' = \ . \ . \ . = \text{const.} = b'.$$

In the diagram representing the values of G as ordinates and the corresponding ones of c as abscissæ, each furnace is represented by a group of straight lines beginning in the point b' and spreading upwards from right to left in the shape of a fan. The constancy of b' does not follow immediately from the above equations, but is found to be in agreement with the fundamental hypothesis expressed by $c = b/(\delta + a)$. A further conclusion drawn from the experimental data is that the concentration of nitric oxide on breaking of the arc is independent of the power of the arc, and almost independent of the detailed construction of the furnace, although characterised by its type; such a conclusion is, however, based on a comparatively small number of results.

The magnitudes of b and b' are regarded as characterised principally by the density of the energy in the region where the nitric oxide is formed, and the technical plant now in use leaves considerable room for increasing them; the magnitude of a should be as small as possible.

T. H. P.

1453. *Influence of Various Conditions on the Oxidation of Nitrogen in the Voltaic Arc.* **A. V. Schaposchnikow, A. Gudima, and V. Kutovski.**

(Russian Physico-Chemical Soc., Journ. 45. pp. 1076–1091, 1913.)—Experiments made with an arc passing between carbon electrodes show that, as the air-supply, V (cub. m. per hour), is increased, the ratio of V to the power consumed, KW, also increases. The yield of nitric acid per kw.-hour at first increases to a maximum of 65·3 gm. for V/KW = about 1, then diminishes somewhat, and finally increases again to 78 gm. per kw.-hour for a value 1·90 of the ratio V/KW. With both dry air and air saturated with moisture, the percentage of nitric oxide in the issuing gases increases to a maximum, and then decreases as the air-supply is continuously increased, but the wet air gives the higher yields in all cases, the difference in yield diminishing as the air-supply increases. The action of the moisture is probably expressed by the equations: $N_2 + 2H_2O = 2NO + 2H_2$ and $2H_2 + O_2 = 2H_2O$.

As material for the electrodes, carbon is greatly to be preferred from an industrial point of view. It gives a very constant arc, requires no cooling arrangement, and allows of the ready introduction into the arc of extraneous substances; it burns away rapidly, but this may be avoided by coating the lateral surfaces electrolytically with nickel. Of metallic electrodes, those of copper give the best results, whilst the use of Pt is not to be recommended.

T. H. P.

1454. *Fixation of Atmospheric Nitrogen by Means of Boron Compounds.* I. **A. Stähler** and **J. J. Elbert.** (Ber. Deut. Chem. Gesell. 46. pp. 2060–2077, 1913.)—The object of the authors' experiments was to determine the conditions under which boron nitride may best be obtained from naturally occurring compounds of boron. Since in such compounds the boron is generally combined with oxygen, it was necessary to investigate first the best methods for their reduction and then the combination with nitrogen of the boron or boride formed. The reduction of boron trioxide by carbon begins to take place at 1200°; in the presence of nitrogen, calcium borate (borocalcite) undergoes reduction at 1280°, reaction probably taking place according to the equation: $CaB_4O_7 + 8C + 3N_2 = 4BN + CaCN_2 + 7CO$.

The electrolysis of molten borax gave yields of boron to the extent of 12·1 %. Carbon electrodes were first used, but they broke off repeatedly at the surface of the fusion; iron electrodes lasted longer, but they also broke off after a time. Attempts to reduce boron trioxide by means of calcium carbide at 1625° made it probable that the product of reaction was calcium boride, which has previously been prepared by Moissan.

Before carrying out further experiments on the production of boron nitride it was necessary to determine its stability; it was found that decomposition with evolution of nitrogen only commenced to take place at 2450°; this temperature of decomposition holds only in the presence of carbon, since the boron nitride was contained in a graphite crucible.

The next experiments were confined to mixtures of carbon with either boron trioxide or borocalcite. These were heated to different temperatures in an atmosphere of nitrogen under different pressures, a special electrical furnace having been constructed in which reactions could be carried out at pressures up to 500 kg./cm.^{2}, and at temperatures up to 2500°. With mixtures of boron trioxide and carbon and nitrogen at atmospheric pressure, the best yield, 26–28 % of boron nitride, is obtained between 1500° and 1700°. With increasing pressure the yield increases, more than 85 % of boron nitride being obtained at a pressure of 70 kg./cm.^{2} and a temperature of 1600°. When the boron trioxide is replaced by borocalcite, a nearly theoretical yield of boron nitride, according to the equation given above, is obtained when the temperature is maintained at 1350° for 30 minutes and 1400° for 15 minutes; increase in pressure of the nitrogen has no effect on the yield. At normal pressures the amount of nitrogen absorbed per gm. of boron is much greater with borocalcite than with boron trioxide; only at very high pressures are better results obtained with boron trioxide than with borocalcite. T. S. P.

1455. *Ageing of Alloys of Silver and Tin.* **W. A. Knight.** (Chem. Soc., Journ. 105. pp. 639–645, March, 1914.)—The ageing of the alloy Ag_3Sn is not accompanied by increase in weight and is not produced by the action of either ozone or an acidified concentrated solution of hydrogen peroxide, so that it cannot be regarded as due to superficial oxidation. The phenomenon is not prevented by the presence of Mg in the alloy, whilst grinding in an agate mortar neither ages the unaged filings nor renders aged filings unaged. Hydrogen sulphide is without action on the weight of the alloy or its capacity to absorb mercury. The presence of an admixture of tin or silver with the alloy diminishes the difference between the aged and unaged alloys as regards the amounts of mercury they retain. When heated at 100° in coal-gas the alloy is completely aged in 20 minutes. Dilatometric measurements show that the volume of the alloy decreases by about 0·4 per cent. during ageing. T. H. P.

1456. *Alloys of Aluminium and Silicon.* **C. E. Roberts.** (Chem. Soc., Journ. 105. pp. 1383–1386, May, 1914.)—Reinvestigation of the thermal diagram of the Al-Si alloys in order to determine the possibility of the existence of either a compound of the two elements dissociating at high temperatures or an allotropic modification of Si stable above 1200°, results in complete confirmation of W. Fraenkel's statement that the alloys form a simple eutectiferous series, the eutectic melting at 578° [see Abstract No. 1324 (1908)]. That no compound is formed is supported by the observation that no silicon hydride could be detected when the alloys were dissolved in acids, and the plotted eutectic arrests confirm this conclusion. Microscopic study of the structure of the alloys is in accord with these results. T. H. P.

1457. *Second Report to the Corrosion Committee of the Institute of Metals.* **G. D. Bengough** and **R. M. Jones.** (Inst. of Metals, Journ. 10. pp. 13–91; Discussion and Communications, pp. 92–118, 1913. Engineering, 96. pp. 299–305, Aug. 29, and pp. 339–342; Discussion, pp. 312–314, Sept. 5, 1913.)—The points of interest deduced from the answers of engineers and others interested in condensers, to the schedule of questions drawn up by the Corrosion Committee are (1) the enormous variation in the life (4 to 25 years) of tubes even from the same batch of material, (2) the peculiar nature of the deterioration which was in nearly every case brought about by dezincification, (3) the impossibility of correlating corrosion with the presence or nature of the electric light installation, (4) the difficulty of connecting corrosion with any definite locality in the tube or condenser, and (4) the shorter life of tubes in land installations using canal, dock, or brackish water instead of sea water. The scale often exists in layers with no sharp line of demarcation between them; the upper layer consists of ferric oxide, carbonates, chloride and sulphates of lime, and magnesia and sand; the intermediate layer is composed of carbonates and chlorides of zinc and copper, while the lower layer which adheres strongly to the tube consists of cuprous and cupric oxides. In a dezincified tube the greenish-blue middle layer is replaced by a white flocculent basic chloride of zinc. In no case could dezincification be traced to carbon deposits. Corrosion phenomena may be divided into two classes:

(1) complete corrosion in which the tube is gradually worn down by removal of the copper and zinc in the proportions in which they exist in the alloy; (2) selective corrosion or dezincification in which the zinc is removed preferentially and locally. The latter is the more common type of failure in practice. The whole subject has been studied by tests made in sea water on tubes of 70 : 30 brass, a special brass (70 % Cu, 28 % Zn and 2 % Pb), Muntz metal (61 % Cu, 39 % Zn), and Admiralty brass (70 % Cu, 29 % Zn and 1 % Sn), both in the laboratory and in an experimental condenser plant.

In the laboratory the following points were taken into account: (1) the volume, temperature, and concentration of the corroding medium; (2) the mode and depth of immersion, (3) the rate of diffusion, (4) the area of metal exposed, and (5) the surface condition of the metal. In stagnant sea water at the ordinary temperature corrosion is always of the complete type, is very slow and decreases in rate with the progress of time. It appears that dissolved oxygen first forms a superficial film of copper and zinc oxides on the surface of the metal. These are dissolved by the CO_2 and NaCl, but the whole of the copper and the greater part of the zinc are immediately precipitated, usually as a flocculent basic chloride and carbonate, while part of the zinc remains dissolved as chloride. Circulation and increase in the concentration of the sea water increase the rate of corrosion, while decrease in the concentration decreases the rate of corrosion and, after prolonged exposure, alters its type. The presence of flaws and spills, contact with particles of coal, coke, graphite, sand basic deposit, etc., have little or no effect on the nature and rate of corrosion. Muntz metal shows the greatest resistance to complete corrosion, Admiralty brass the least, while the other two alloys are about equal and intermediate. Tests made at higher temperatures showed that temperature is the predominating influence in determining the type of corrosion. At 40° C. selective corrosion occurs as well as general corrosion, but at 50° C. the corrosion is almost wholly selective. Selective corrosion is accompanied by the formation of basic zinc chloride which settles and adheres to rough parts of the tubes and intensifies and localises the action, resulting in pitting. Dilution increases, and concentration decreases, the tendency towards dezincification, while the presence of particles of foreign matter with the possible exception of zinc chloride and hydrate has little or no effect. There is no relationship between loss in weight and degree of dezincification, since Muntz metal loses the least in weight and is subject to the greatest dezincification, of the four alloys. Admiralty brass resists dezincification almost completely at 50° C. owing to the powerful protective effect of tin. There is evidence to show that selective corrosion only occurs over a range of temperature. Experiments in the condenser plant corroborated the results of laboratory tests. In the plant, 48 condenser tubes were subject to conditions similar to those ruling in the mercantile marine for 9 hours per day for 9 months. The plant was closed down every night, Saturday afternoon and Sunday. The sea water used contained 3·19 % total chlorides, which increased to 4 % in about 6 weeks, when the sea water was changed. Subsequent examination of the tubes showed that the Admiralty brass and the 70 : 30 brass were most resistant and the Muntz metal least resistant. In all cases attack was most severe near the centre of the tubes where the steam enters the condenser, showing the important influence of temperature. Corrosion occurs most frequently along the bottom of the tubes. Dezincification appears to be inherent in alloys of the brass type and increases with the zinc-content. Electrochemical protection has also been studied and has been traced to the precipitation of calcium carbonate as a firmly adherent deposit by electrolysis of the bicarbonate. This explains how a protective action is exerted at great distances from the anodes.

With regard to the practical problem it is recommended that the best methods of hindering dezincification are by the abandonment of the use of plain brasses and substituting alloys of the type of the special brasses containing tin or lead. In addition, the temperature in the condenser should be carefully controlled, and the use of electrochemical protection considerably extended. F. C. A. H. L.

1458. *Bronze.* **J. Dewrance.** (Inst. of Metals, Journ. 11. pp. 214–223; Discussion, pp. 224–234, 1914. Engineering, 97. pp. 405–406, March 20, 1914.)—Gives the results of tensile tests taken at various temperatures up to 700° F., on bronze containing copper 88, tin 10, zinc 2, and also copper 87·5, tin 10, zinc 2, lead 0·5 %. In the case of the alloy without lead there is a considerable decrease in strength as the temperature of the test is increased, whereas in the case of the alloy containing lead no serious decrease is noted until a temperature of 500° F. is exceeded. C. O. B.

1459. *Influence of Phosphorus on some Copper-Aluminium Alloys.* **A. A. Read.** (Inst. of Metals, Journ. 10. pp. 344–368, 1913. Mech. Eng. 32. pp. 444–447, Nov. 7, 1913. Abstract.)—After a few preliminary tests, it was decided to thoroughly examine the effect of phosphorus on copper alloys containing 5 % and 10 % Al. With the alloys containing 10 % Al, only about 0·2 % P can be added; with above this amount, a metal is obtained which on filing or turning gives off an odour of phosphine due to the decomposition of aluminium phosphide. The effect of very small quantities of P on annealed samples is to raise the yield-point a little and to increase the elongation and reduction of area considerably, while the maximum stress remains practically the same.

A much larger amount of phosphorus can be added to the 5 % Al alloys: the bars containing 1 % P were worked without the slightest trace of phosphine being detected. On annealed samples, the yield-point and max. stress rise a little and the reduction of area is lowered as the P increases.

In chill castings, with increasing P the yield-point rises continuously and the ultimate stress attains a maximum at 0·52 % P, but the elongation and reduction of area fall rapidly. The results of alternating stress tests are given which show the detrimental effect produced by annealing the 10 % Al alloys. Hardness tests obtained by the Shore scleroscope and the Brinell method are also given. The relative hardness numbers recorded by the two methods are in fairly close agreement, and show that in the 10 % Al alloy, with the small increasing amounts of P, the hardness of the annealed bars is unaltered, but with the cold-drawn bars the hardness is raised slightly. With the 5 % Al alloys, small additions of P do not alter the hardness of the annealed bars, but in the chill castings a considerable increase in hardness is obtained after 0·25 % P is passed.

Results of tests for electrical conductivity are given which show that the conductivity of the 5 % alloy is only very slightly greater than that of the 10 % alloy. The effect of P is to diminish the conductivity in both cases, but with the 5 % alloy the diminution is much more marked, being with the same amounts of P more than twice as great as in the 10 % alloy. The presence of P is found to lower the melting-points of both series of alloys.

A number of corrosion tests were carried out and the results show that a pure fresh water had an exceedingly small action on the alloys, while in the case of sea water the effect of small quantities of P is to reduce the loss of weight due to corrosion.

The solubility of P in copper is found to be increased by the presence of Al. C. O. B.

1460. *Critical Ranges, Physical Properties, and Microstructure of Manganese Steel.* **W. S. Potter.** (Amer. Inst. Mining Engin., Bull. 88. pp. 601–628, April, 1914.)—Heating curves of manganese steel showed well-defined retardations at 850–875° C., 1100–1140° C., and at 1200–1210° C., while slight retardations were recorded at 350–375° C., 450–475° C., 575° C., 675–735° C., 975–1025° C. Cooling curves showed well-defined retardations at 850–825° C., 1125–1060° C., 1200–1170° C., and slight retardations at 1030–1020° C., 950–925° C., 710–650° C., 550–525° C., 450–420° C., and at 350–325° C. The melting intervals occurred between 1350° and 1375° C., and the freezing intervals between 1370° and 1275° C., according to the composition of the alloy. Experiments have also been made with a view to determining the effect of heat-treatment on the strength and ductility of the alloys. Prolonged soaking at high temperatures followed by quenching at a lower temperature decreases both strength and ductility. The max. strength and ductility was exhibited by a specimen quenched from 815° C., while the minimum strength is shown by alloys quenched from about 650° C. Microscopic study of the alloys containing 9–20 % Mn and 1–2 % carbon showed that the structural constituents were γ-iron or austenite, cementite, a double carbide of manganese and iron, a eutectic of cementite and austenite, and a eutectic of lamellar structure. In addition, martensitic, troostitic and sorbitic structures were met with. Between 1370° and 1270° C. γ-iron freezes out, while the eutectic separates at 1125° to 1080° C. The mechanical break-up of austenite begins at 850–825° C. At 710–650° C. carbides separate between the grains. Magnetism increases between 550° and 525° C. and is accompanied by further carbide separation. During heating of originally austenitic steel there is a preliminary break-up at 350° C., which is continued at 450–470° C. and completed at 575° C. Magnetic carbides of iron and manganese separate at 475° C. and at 575° C. In rolled steel, solution of carbides begins at 725° C. and is completed at 850–870° C. with the re-formation of austenite. F. C. A. H. L.

1461. *Structural Changes of Iron during Annealing.* **D. Ewen.** (Int. Zeitschr. Metallog. 6. pp. 1–16, March, 1914.)—When polished specimens of metals are heated *in vacuo*, network patterns are produced on the polished surface.

In the case of wrought iron, three distinct types of heat relief have been obtained corresponding to initial α and β-iron structure, γ-iron structure, and final β and α-iron structure. By means of tests at various temperatures, these structures have been attributed to allotropic changes in the iron. The development of the α-iron heat relief structure on heating has been ascribed to selective volatilisation from the crystal boundaries. The γ-iron heat relief and the final β- and α-iron heat relief obtained on cooling may be attributed to differences in dilatation of the allotropic modifications involved. The etching effect obtained above Ar_3, especially where the metal is heated by the direct passage of a heavy current through it, probably results from a species of electrical disintegration.

It is shown that these networks or "heat-relief" patterns may be taken as truly expressing the crystalline structure of the metal at various temperatures. [See also Abstract No. 752 (1910).] C. O. B.

1462. *Embrittling of Iron by Caustic Soda.* **J. H. Andrew.** (Faraday Soc., Trans. 9. pp. 316–329, March, 1914.)—Microscopic examination of an iron tube which had become extremely brittle during use in a caustic soda concentrator showed large crystals and an intercrystalline fracture. The cell walls were very thick and the grains themselves showed peculiar markings. Experiments on the corrosion of polished and unpolished specimens of wrought iron and 0·5 % carbon steel in hot concentrated caustic soda showed that wrought iron is corroded more rapidly than steel. The rate of corrosion diminishes with the time. After a short time the steel becomes coated with a black deposit which also ultimately makes its appearance on the wrought iron, but after a much longer time. This deposit is most probably Fe_3O_4, and ultimately converts the loss into a gain in weight. Polished specimens corrode less rapidly than unpolished specimens, either because of the lower solubility of the amorphous phase in caustic soda or because of the uniformity of surface preventing electrolytic action. A white precipitate formed during the tests was found to consist of silica and sodium ferrate. Evolution of gas occurred, and the gas evolved was proved to be hydrogen. During the first few weeks the grains of the wrought iron were observed to grow and the metal became extremely brittle. After a further period, however, malleability was restored. These recrystallisation effects have been attributed to the absorption of hydrogen. It has been shown previously that amorphous metals occlude hydrogen much more rapidly than crystalline metals do. On this basis it appears probable that hydrogen is rapidly absorbed by the intercrystalline amorphous phase. It diffuses along the paths occupied by this phase and forces apart the allotriomorphic grains. When the concentration of the hydrogen reaches a certain limit, diffusion takes place into the crystalline phase, sets up mechanical disturbances, and probably causes recrystallisation. These two hydrogen-saturated phases produce a hydrogen cell, their potential differences are thereby lowered and the electrolytic corrosion is reduced. The passivity of iron produced by immersion in caustic soda can be explained on similar lines. Previous saturation with hydrogen is also found to reduce the rate of corrosion. The author suggests that the crystallisation of electro-deposited iron as it cools through Ar_3 is due to the evolution of hydrogen. F. C. A. H. L.

1463. *Nitride of Iron.* **G. Charpy** and **S. Bonnerot.** (Comptes Rendus, 158. pp. 994–996, April 6, 1914.)—When subjected to the action of ammonia at a red heat the surface of a piece of iron or steel begins to harden, then fissures are produced, and finally exfoliation takes place, resulting in the formation of small particles of Fe_2N. Small shavings of iron are readily and completely converted into nitride. The rate of formation is slow below 500° C. and increases with rise of temperature. At the same time the formation is governed by the inverse reaction, *i.e.* reduction of Fe_2N by hydrogen, so that it is necessary to increase the rapidity of the current of ammonia as the temperature rises: the most favourable conditions are observed between 650° and 700° C. The reduction of Fe_2N by hydrogen commences a little below 350° C. and attains a max. rate between 500° and 600° C. In nitrogen at atmospheric pressure decomposition begins at just above 350° C. Decomposition is complete above 600° C., but experiments below 600° indicated the existence of a nitride, Fe_4N, more stable than Fe_2N. Pressure reduces the rate of decomposition, but even a pressure of 18 atmos. will not cause the direct combination of iron and nitrogen. From the experiments made it does not appear possible that iron nitride can exist in iron or steel produced industrially. The small amount of nitrogen present in such products must either exist in the free state or in combination with some element other than iron. F. C. A. H. L.

1464. *Thermal Expansion and Rate of Solution of Iron-Carbon Alloys.* **J. Driesen.** (Ferrum, 11. pp. 129–138, Feb., and pp. 161–169, March, 1914.)—Experiments have been made on the thermal expansions between 20° and 1000° C. of fairly pure iron-carbon alloys containing 0·05 to 3·9 % C, in both the annealed and quenched conditions. This study has been extended by determining the rate of solution in N/10 sulphuric acid solution of quenched, tempered, and annealed alloys. Up to 500° C. heating and cooling curves were identical within the limits of experimental error, but above this these curves did not coincide and the bar appeared to have undergone a permanent change of length. On the curves showing changes of length with temperature, irregularities are observed at 180° C. which are ascribed to a transformation in the cementite: α cementite (stable below 180° C.) has a lower coefficient of expansion than β cementite, whose coefficient is about equal to that of ferrite. The method can be used for determining the critical points of the iron-carbon alloys, giving results which agree with those obtained by other methods. There is, however, no definite indication of the α-β change. With normal rates of heating and cooling the pearlite change-point occurs at 739° C. on heating and 707° on cooling. Extremely slow cooling gives a higher value for the Ar_1. In alloys containing over 0·85 % C the coefficient of expansion is approximately constant above the change-point. As a function of concentration in the same alloys the coefficient of expansion shows a well-defined maximum at 1·7 % C. A max. change of length in the transformation range is observed at a concentration of 0·88 % C. Quenched steels show a contraction at 275° to 340° on tempering, and in alloys with over 1 % C another contraction is observed at 100–150°. The rate of solution of hardened steels shows a well-defined minimum on tempering at 170° and a maximum after tempering at 350°–420° C. Curves showing the relationship existing between rate of solution and carbon-content of hardened steels tempered alike exhibit discontinuities in the neighbourhood of 0·9 % C. F. C. A. H. L.

1465. *Influence of Nickel on some Copper-Aluminium Alloys.* **A. A. Read** and **R. H. Greaves.** (Inst. of Metals, Journ. 11. pp. 169–207 ; Discussion, pp. 208–218, 1914. Engineering, 97. pp. 399–404, March 20, 1914.)—Contains the results of an investigation of the influence of nickel on copper-aluminium alloys containing 5 % and 10 % of Al. The triple alloys examined in each of the two series contained from 1 % to 7 % of Ni. The effect of Ni on the rolling properties is recorded, and this is followed by results of wire-drawing tests and tensile tests. A summary is given of the effects of Ni on the mechanical properties of chill-castings, annealed rods, cold-rolled bars, quenched bars, and air-cooled bars of the two series.

Alternating stress tests carried out on the Arnold machine are described, and also the results of hardness tests by the Shore scleroscope and the Brinell method.

The melting-points as determined by a thermoelectric pyrometer and electrical resistance of annealed and quenched wires are given. The results of corrosion tests carried out in sea water and in fresh water and the results of microscopic examination are also included. C. O. B.

1466. *Osmotic Pressure and Moist Air.* **W. D. Bancroft.** (Journ. Phys. Chem. 18. pp. 67–69, Jan., 1914.)—The author quotes from the Journal of the

Chemical Society for 1854 three cases in which casks of molasses housed in a damp warehouse had imbibed water apparently by osmotic pressure against moist air instead of against liquid water. In one case, apart from much loss by bursting of the barrels, a gain of weight of 23¼ cwt. on 1270 cwt. was recorded, in another 56 cwt. on 4160 cwt.; in a third case 6·8 galls. of water (68 lbs.) were found to have been drawn into one cask during 8¼ years.

T. M. L.

1467. *Flame Reactions*. II. **W. D. Bancroft** and **H. B. Weiser.** (Journ. Phys. Chem. 18. pp. 281–336, April, 1914.)—Further experiments [see Abstract No. 1005 (1914)] lead to the following conclusions. An absolutely transparent gas will emit no light at any temperature unless some reaction takes place. A coloured vapour may emit a purely thermal luminescence, but this does not prove that the actual luminescence in any particular case is entirely thermal. The fact that the luminescence of a moderately transparent vapour has a lower intensity than the corresponding luminescence of a black body at the same temperature is not necessarily a proof of thermal luminescence. There seems to be no justification for the assumption that temperatures of about 6600° and 7200° are reached, in the hydrogen and carbon monoxide flames respectively. The statement that a candle flame will melt platinum but will not melt sodium chloride is inaccurate. Since the luminescence of any given flame may be due wholly or partly to chemiluminescence, it is important to determine the reactions occurring in the flame and to what extent the luminescence is due to these reactions. In the study of flame reactions, distinction must be made between colours due to emission and those due to absorption.

Study of the flame reactions of tin and its salts shows that the conversion of tin to stannous salt is accompanied by carmine luminescence and that of stannous salt to stannic salt by green and usually more intense luminescence. The reactions which produce these are mainly $Sn \longrightarrow Sn^{\cdot\cdot}$ and $Sn \longrightarrow Sn^{\cdot\cdot\cdot\cdot}$, but it is unknown what luminescence is due to the conversion of stannous or stannic ion into the corresponding undissociated salt; no characteristic luminescence has yet been detected for the reverse reactions. The differences between the spectra of tin chloride, bromide, and iodide are due to the absorption spectra of the halogens and the salts and to the light emitted by the reactions of the halogens themselves.

The conversion of copper to cuprous ion is accompanied by a green, that of cuprous ion to cuprous salt by a red, and that of cuprous ion to cupric salt by a blue, luminescence; it has not yet been determined what luminescence is due to the conversion of cupric ion to cupric salt. The intensity of the green luminescence is so great that the unaided eye does not notice any blue in the ordinary copper flame even although the copper burns chiefly to cupric salt; no characteristic luminescence has been detected for the reverse reactions. Undissociated cupric chloride vapour has a violet-red colour, but this must not be mistaken for luminescence. T. H. P.

1468. *The Theory of Adsorption*. **A. Eucken.** (Deutsch. Phys. Gesell., Verh. 16. 7. pp. 845–862, April 15, 1914.)—On the assumption that gas adsorption on a solid body represents the formation of a layer of compressed gas owing to physical forces of attraction, the author deduces formulæ for the adsorption of an ideal gas. It is found that, in harmony with experiment, the absorbed amount is, for low pressures, proportional to the gas pressure. The formula also in general reflects well the dependence of adsorption on temperature. In the case of a real gas saturation of the surface takes place at high compression owing to the diminution of the compressibility. In the case of the adsorption of a vapour, saturation can, as a rule, be effected only on a strongly pitted surface, and not on a smooth surface. A. F.

1469. *The Critical Point, and the Significance of the Quantity* b *in the Equation of van der Waals.* **T. W. Richards.** (Amer. Chem. Soc., Journ. 36. pp. 617–634, April, 1914.)—In a discussion of the above point, the author points out: (1) The value of *b* in carbon dioxide must be admitted to vary according to conditions in such a way that, although fairly constant under moderate pressures, it diminishes greatly with very high pressures. (2) The value of *b* in hydrogen and CO_2 is probably affected by temperature, the nature of this effect being dependent on the value assumed for *a*. Both of these probabilities seem to be accepted by van der Waals himself. (3) The value of *b* with the monatomic gas helium is found to have a decidedly negative temperature coefficient. (4) This decrease in *b* with rising temperature seems to imply that the helium atoms are compressed by collision, the greater compression taking place at higher temperatures because of the greater kinetic energy of collision. This conclusion suggests further that uncombined atoms are not expanded by rise of temperature—a conclusion in keeping with the solely translatory effect of heat on monatomic gases. (5) In polyatomic molecules this effect may be supposed to be partly counteracted by some sort of expansion of the molecule due to the energy expended within the molecule, as indicated by the larger specific heat of polyatomic molecules. (6) Therefore, since *b* may be supposed to be a function of the actual size of the molecules, one is driven to conclude that molecules may change the effective size which they assume under collision. (7) If the atoms and molecules are thus compressible, van der Waals' conclusion that *b* is equal to four times the actual molecular bulk falls to the ground; one must assume that the molecules really occupy considerably more space. It is not unreasonable to imagine that the actual molecular bulk (when the molecules are not compressed by collision or cohesion) is probably even larger than *b*, perhaps about the critical volume. (8) It is pointed out that as a matter of fact *b* occupies very nearly the bulk of the corresponding liquid at a temperature somewhat above the boiling-point in many cases. This again shows that in the state of gas, when not compressed by cohesion, the molecules must be somewhat larger than *b*. (9) The approximate, although often unsatisfactory, agreement of the equation of van der Waals at the critical point is perhaps less significant than is usually imagined: the continuity between the liquid and the gaseous states may be supposed to exist only at the critical point. (10) The critical temperature is defined by supposing that it is the point where the kinetic energy of the molecules is just barely enough to separate them when the outside pressure is sufficient to bring, on the average, the molecular surfaces into contact. Therefore the critical volume may be about the true volume of the non-cohesing molecules, as stated above. (11) From these conclusions it is evident that the theory of compressible atoms affords a satisfactory explanation for the inadequacy of the equation of van der Waals, and the equation of corresponding states derived from it. The latter equation would be expected to hold better than the former, because the same kinds of deviations often exist in different gases, and the method of comparison may eliminate these. A. F.